Friden

CALCULATOR
MECHANICAL OPERATIONS
"W" LINE MODEL

DESIGNED FOR USE AT THE SERVICE TRAINING CENTERS

Friden, *Inc.* HOME OFFICE, SAN LEANDRO, CALIFORNIA

FOREWORD

You are beginning an intensive eight week training period covering the mechanical operation, adjusting and servicing of the Friden Calculating Machine. As a class, you will begin this training together and will stay together during the entire course. Only the material outlined by the instructor wili be covered during any particular phase of this training. It will be much more beneficial to you to review material already covered, rather than to begin studying future assignments ahead of schedule. To completely cover all phases of theory, adjustments, and trouble shooting in an eight week period, every minute of time must be utilized. Your days here at the Training Center will be busy ones. Be alert and thinking all the time. Naturally, we do expect you to do some extra work and study on your own time.

If you are to become a successful Friden Service Technician you must know exactly how the machine functions. Make it your goal to know this! Know the purpose of every part that is a part of the machine. If it did not have a purpose, it would not be there! Acquire as much knowledge of the machine as you possibly can while here at the Training Center. After leaving the Training Center you will not have the time to devote to study as you do here.

You are not expected to develop into an experienced Friden Service Technician in the short time spent at the Training Center. However, it is our endeavor to instill in you a good knowledge of the mechanical operation and adjustment of the Friden Calculating Machine. We will also show you a method of mechanical reasoning so that you may analyse and correct a service problem quickly and properly.

The Training Course is made up of sections as listed:

1. Mechanical Operation And Tests.
2. Disassembly.
3. Assembly, Adjustments And Tests.
4. Problems, Analyzing And Tests.

The first section of the course includes mechanical operations and is designed for you to learn how the machine functions mechanically. The reason for the mechanical operations being placed first is important. To service a Calculator you must know; what each part does, what each group of parts do, the group of parts that make up any particular sequence of mechanical operation. On the following pages of this manual are sketches of the mechanical functions of the machine along with questions that you are to answer using the part names shown in these sketches. These mechanical functions must also be traced on the machine you have in front of you. You will be asked to trace them on the machine for the instructor. Examinations will be given periodically.

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STUDY METHOD SUGGESTION

The job of the student does not end with the learning of the material presented in the Training Center to the point of perfect repetition in an examination.

Your job ends only when the material has become so much a part of you that you use it effortlessly in solving problems which come up in your daily work.

Then and only then can you say that you have "learned."

Up to then you have merely studied.

USE THE LEARNED MATERIAL

> You will not remember material unless you review it.
>
> The best way to review is through use.

REVIEW YOUR MATERIAL FREQUENTLY.

> Keep a list of the difficult points in your studies as you go along.
>
> Points that are difficult will be under-learned and easily forgotten.

STUDY WITH THE INTENT TO REMEMBER

> Remind yourself as you study of the fact you are going to be called upon to use what you are learning. Especially later, when you are in the field.

If you want to remember what you learn, use it as frequently as you can, make your reviews cover the more difficult parts, especially well, and learn with the intent to remember.

SUMMARY OF VARIOUS MODELS MANUFACTURED

Friden, Inc. has manufactured several calculators in the 8 and 10 bank models. The original machines were the models A and B. These machines had a dark green colored one-piece cover. The machine would add, subtract, divide, and multiply by the use of the shift keys and plus key. These models were improved into the models C and D and retained the dark green colored single-piece case. Later, these models were improved to the gray case model C and D. Dividend tabulation was added to the model C and the model D had cross tabulation. Prior to making the gray case machine, another model was introduced. This was the model F, a multiplier model with a row of multiplier keys along the top right side of the top cover. This also had a green case but was a four-piece case. The model F was improved to the model FT, a gray case machine with dividend tabulation. The first automatic multiplier model was a model S or Supermatic model. The multiplier keys were located in the lower left of the top cover. This was a 10 key means of selecting the multiplier. The first model was in a green case, however, the machine was later improved to the model S in a gray case, then to the model ST. This was the automatic machine which would do addition, subtraction, automatic division, dividend tabulation, multiplication, accumulative multiplication, negative multiplication, and multiplier clear. The model C, D, S, ST, in the gray case (the gray line) existed until 1949 when the STW was introduced. This machine has a taupe covered case or brown case. After the STW was introduced the models CW, DW, SW, SRW, and ACG were introduced. These are known as the W line machines.

APPLICATION OPERATING INSTRUCTIONS

Before getting started into the mechanical tracings it is wise to know a little about how to operate the machine. We do not intend for you to become an expert at application. This is the job of the Salesman but as a Serviceman you should have some knowledge of application. Many times you will be asked by an operator to explain a function of the machine. If you know the answer you can be of assistance; if you do not know the answer or are not sure of yourself, do not attempt an explanation that will lead to confusion. Tell the operator you are not sure of the answer but that you will ask a Salesman to stop in.

To familiarize you with some basic applications that will assist you in this mechanical course you are to refer to the following pages of the Model STW Operating and Instruction booklet and work the problems. One day will be alloted for this instruction. Call upon the instructor for assistance, if needed.

Pages 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15.

Pages 18, 19 20, 21, 22, 23, 24, 25, 26, 27.

Pages 30, 31, 32, 33.

Pages 34, 35, 36, 37, 38, 39, 40, 41 42, 43, 44, 45, 46, 47, 48.

Pages 67, 68, 69, 70, 71.

DIRECTION OF PART MOVEMENT

When an operation is described or when you write the description, remember the direction of motion of parts will be as if you are facing the front of the machine.

The right means to the right side of the machine; the left means to the left side of the machine.

If you should be facing the back of the machine, the part movement is still to the right or the left of the machine as if facing from the front. Front and rear movement description is the same as if facing from the front.

Shafts rotate even though they do not turn a full 360 degrees.

ROTO-FLOW ONE WAY DRIVE PRINCIPLE:

There are many models of the Friden Calculator, but basically each is similar and capable of addition, subtraction, and carriage shift. By utilizing various mechanical means, the basic function of addition, subtraction, and carriage shift is controlled and operated to accomplish automatic division and automatic multiplication.

The basic design of the Friden Calculator incorporates the Friden Roto-Flow One Way Drive Principle. That is, the main rotating parts that perform the calculations revolve in one direction. The parts that register the calculation and those that shift the carriage also revolve, but when required are capable of revolving in two directions.

At this point we will elaborate on the parts of the machine shown in Sketch 1. As you read and check the parts on the sketch, also locate them on the machine. This will familiarize you with their location.

The machine has a keyboard section in which the selecting keys are located. Under the keyboard are the selecting arms. At the rear of the selecting arms are the selecting gears. The selecting gears are located on the selecting gear shafts. At the end of the selecting gear shafts are the genevas and inserted in these are the add-subtract gear shafts. On the add-subtract gear shafts are the transfer gears and the add-subtract gears. Under the transfer gears are the transfer pins.

Under the selecting gears are the actuators which are geared to the drive shaft and on the actuators are the geneva discs. Located in the carriage are the counter dials, the accumulator dials, and the transfer levers. Under the add-subtract gears is the add-subtract gate.

Because of the Roto-Flow One Way Drive Principle, the main rotating parts directly connected and revolving in one direction when turned by the actuators are: (in operational sequence) the selecting gears, selecting gear shafts; add-subtract gear shafts; add-subtract gears, and transfer gears.

The rotating parts that register the calculation and are capable of rotating in both directions when required are: The accumulator dials (upper) and the counter dials (lower). Both the upper and the lower dials have a means of transferring that will be discussed later.

SELECTING GEAR SHAFTS AND SELECTING GEARS:

For each keyboard column there is one selecting gear shaft; the 10 column calculator has 10 shafts and the 8 column calculator has 8 shafts. There are two shafts for each actuator and starting from right to left with the number 1 actuator, the shafts alternate long and short. The "W" line models do not have shafts in the 11th and 12th positions.

On each shaft are 2 selecting gears. The front gear when moved into position by the selecting key depression can contact the 1 through 5 actuator segments and the rear gear when moved into position can contact the 6 through 9 actuator segments.

Each keyboard column has 2 selecting arms and starting from right to left they alternate long rear and short rear, then long front and short front. The first column selecting gears are in position to be brought into contact with the number 1 actuator rear section segments and the second column selecting gears are in position to be brought into contact with the number 1 actuator front section segments. This arrangement progresses across the machine.

The purposes of the selecting gears are to contact the actuator segments that correspond to the selecting key that is depressed and to cause a rotation of the selecting gear shafts. The selecting gear shafts transmit the rotary motion of the selecting gears to the add-subtract gear shafts. The selecting gear shafts also have the geneva at the rear of each shaft into which is inserted the add-subtract gear shaft. (The purpose of the geneva will be covered later.)

ACTUATORS:

The calculator has 6 actuators that are rotated by the drive shaft and which are the mechanical means of transferring the selection to the accumulator dials. The actuators also complete the transfer action of the accumulator dials. The number 1 through number 4 actuators on 8 and 10 bank machines have segments that when in alignment with the selecting gears contact and rotate the selecting gears. The number 5 actuator on a 10 bank model has segments but does not when the machine is an 8 bank model and the number 6 actuator never has segments. The number 1, 2, 3, 5, 6 actuators have additional functions which are: The right and left shift by the number 1 and number 2 actuators; the opening of the shift gear locks by the number 3 actuator; the actuation of the carriage clear mechanism by the number 5 actuator; and the division throwout and the extra transfer restore by the number 6 actuator. These functions will be covered at the proper place in these tracing operations.

The actuators that accomplish the selection have one rear section and one front section with each section having two sets of segments. These segments are arranged so each section has one set of teeth numbering from 1 to 5 that correspond with the 1 through 5 selecting keys of the keyboard, and one set of teeth

ACTUATORS: (continued)

numbering from 6 to 9 that correspond with the 6 through 9 selecting keys.

All actuators have a geneva disc which is the means for stopping the geneva after the completion of a selection or a transfer. (This will be discussed later) Attached to the geneva disc is the transfer tooth and the restore cam assembly which restores the transfer gear. (This will be discussed later)

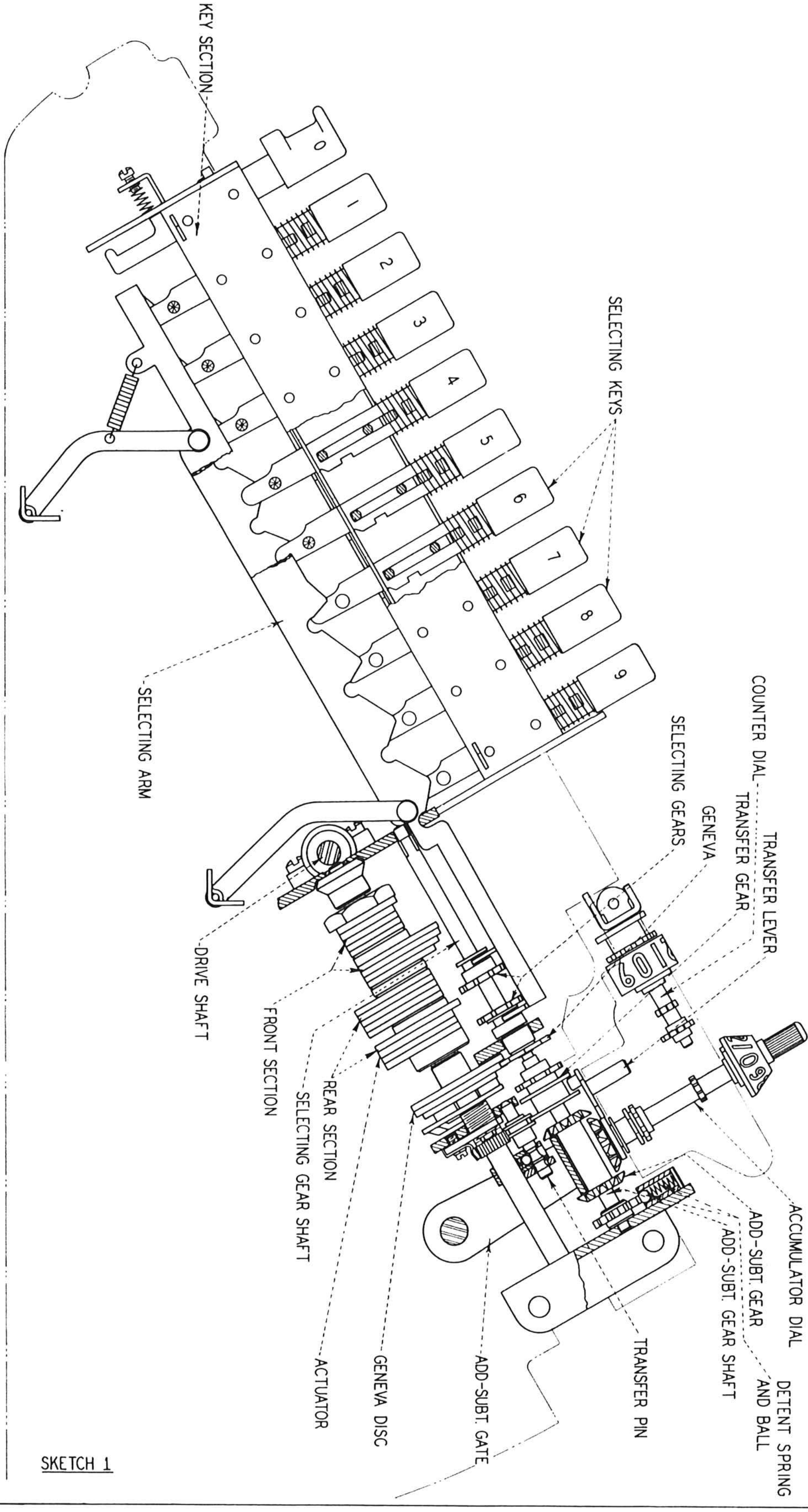
There are 12 add subtract gear shafts and on each shaft is installed an add-subtract gear and a transfer gear with the exception of the first or extreme right shaft.

The purposes of the add-subtract gear shaft are to carry the add-subtract gear and the transfer gear, and to cause the rotation of the add-subtract gear.

The add-subtract gear is a single hub with a 10-tooth gear at each end. The front gear when in mesh with the accumulator dial gear will cause the dial to rotate counter-clockwise or in addition. The rear gear when in mesh with the accumulator dial gear will cause the dial to rotate clockwise or in subtraction.

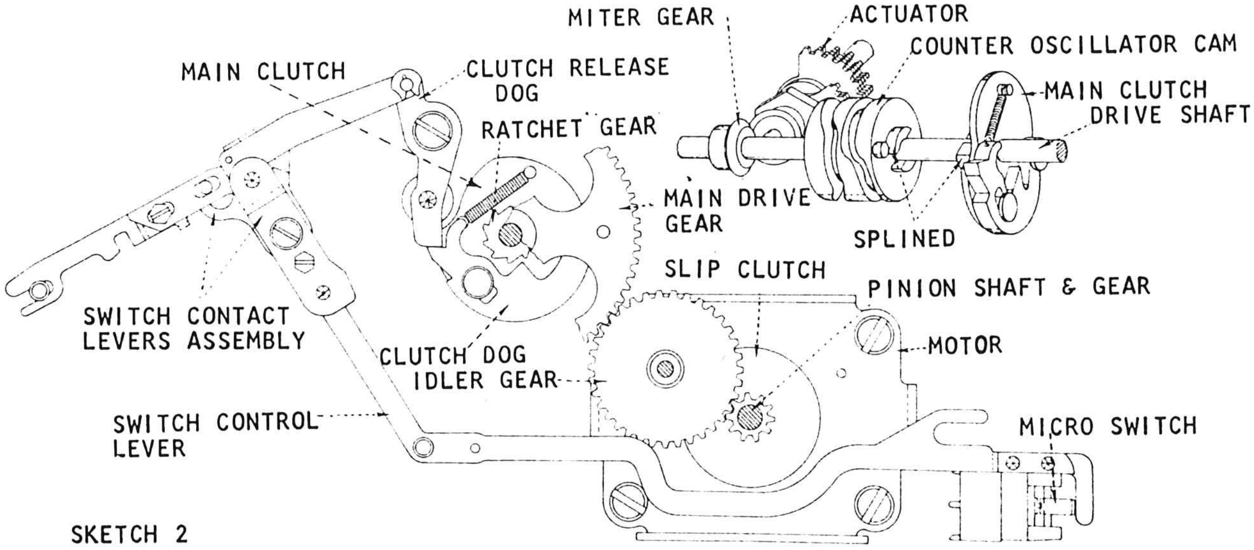
The add-subtract gear shaft has a centralizer at the rear which is the means for centralizing the shaft, the add-subtract gear, and the transfer gear. The centralizing action is obtained by the detent ball and the detent spring located in the rear bearing plate.

The following pages cover the mechanical operations of the aforementioned parts and the entire machine.


KEY SECTION
SELECTING KEYS
0
1
2
3
4
5
6
7
8
9
SELECTING ARM
DRIVE SHAFT
FRONT SECTION
REAR SECTION
SELECTING GEAR SHAFT
ACTUATOR
GENEVA DISC
ADD-SUBT. GATE
TRANSFER PIN
ADD-SUBT. GEAR SHAFT
ADD-SUBT. GEAR
DETENT SPRING AND BALL
ACCUMULATOR DIAL
TRANSFER LEVER
TRANSFER GEAR
GENEVA
SELECTING GEARS
COUNTER DIAL

SKETCH 1

DRIVE:



SKETCH 2

The Calculator is driven by an instantaneous starting 1/30 HP AC-DC motor. The speed of the motor is regulated by a centrifugal type governor and this governor is controlled to allow the rotating parts of the Calculator to revolve at 500 RPM. Further information as to the workings of the motor will come later in the course.

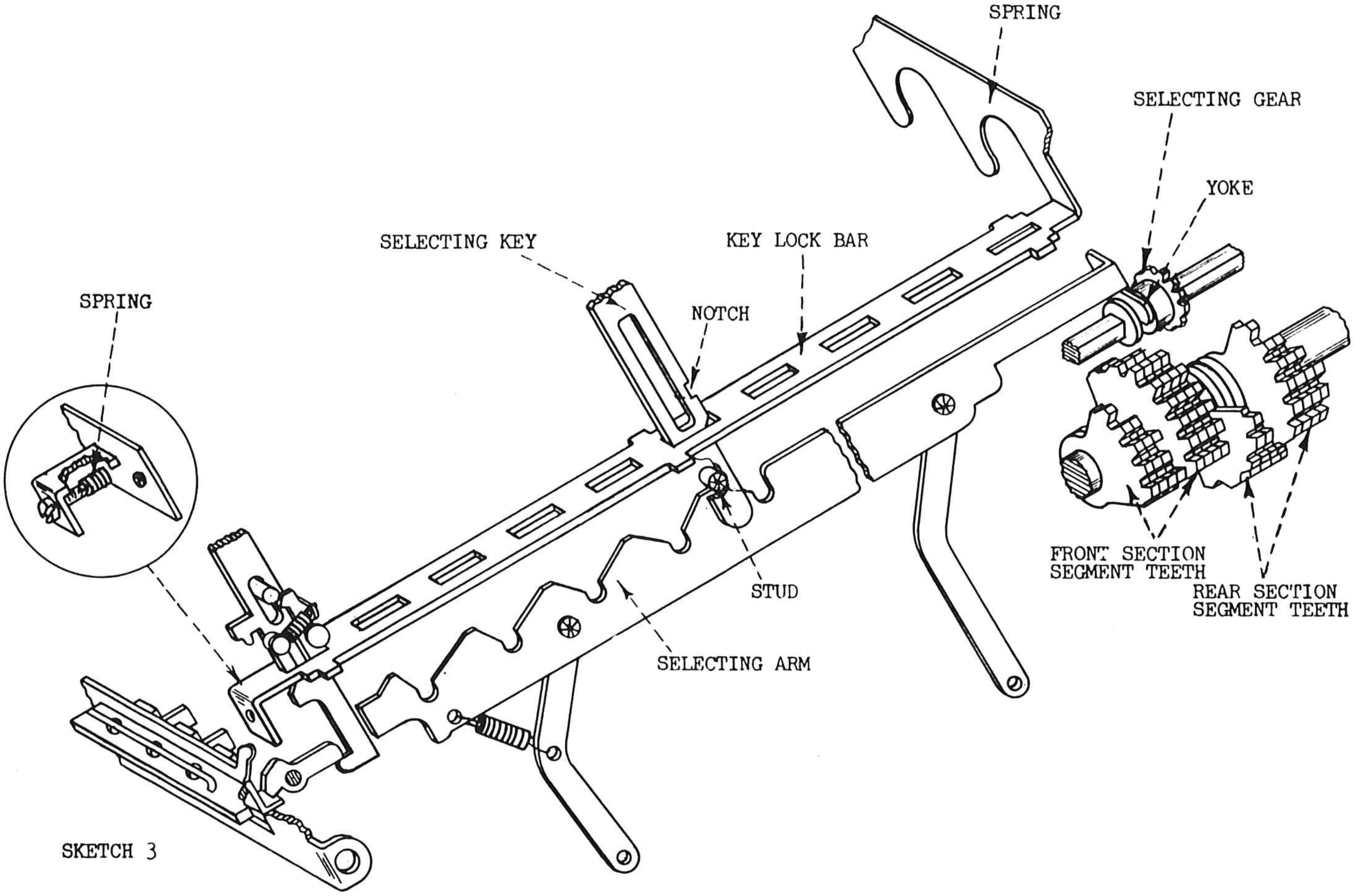
The main rotating parts directly connected and revolving in one direction on each cycle of the machine are: (in operational sequence) the motor; pinion shaft and gear; idler gear; main drive gear; main clutch; drive shaft; and actuators.

The depression of any operating key will cause the actuation of the shift contact levers assembly and the switch control lever. The rear of the switch control lever closes the micro-switch which starts the motor rotating. The rotation of the motor rotates the slip clutch, the pinion shaft and gear, the idler gear, and the main drive gear. Now, as previously mentioned, the depression of any operating key caused the shift contact lever assembly to move; therefore, the clutch release dog is actuated to release the clutch dog. This allows the clutch dog to engage the ratchet gear of the rotating main drive gear. Since the clutch assembly is splined to the counter oscillator cam and the oscillator cam is pinned to the drive shaft, the drive shaft is rotated. Along the drive shaft are six miter gears and in contact with each of these gears is an actuator; therefore, the rotation of the drive shaft will rotate all actuators.

SELECTION:

When you were doing addition you noticed that the number of a depressed selecting key would appear in the accumulator dials. We will now cover the parts involved in this operation. First will be the parts involved to position the selection mechanism. Second will be the engagement of the parts that will cause the dials to turn. Third will be the transferring of the selection to the dials.

The main keyboard consists of either 8 or 10 columns of numeral keys which number from 1 to 9. There is a blank key at the front of each column which is the individual key lock and clear key. The depression of these keys will determine the selection that is to be used in the calculation. Under the keyboard are the selecting arms which have a yoke at the rear that is connected to the selecting gear. There are four types of selecting arms: The short front which selects the 1 to 5, and the long front which selects the 6 to 9. These selections are made on the front section segment teeth of the actuator. The short rear which selects the 1 to 5, and the long rear which selects the 6 to 9. These selections are made on the rear section segment teeth of the actuator. The selecting arms alternate from right to left as such: Long rear and short rear for the first column of selecting keys, then long front and short front for the second column of keys.

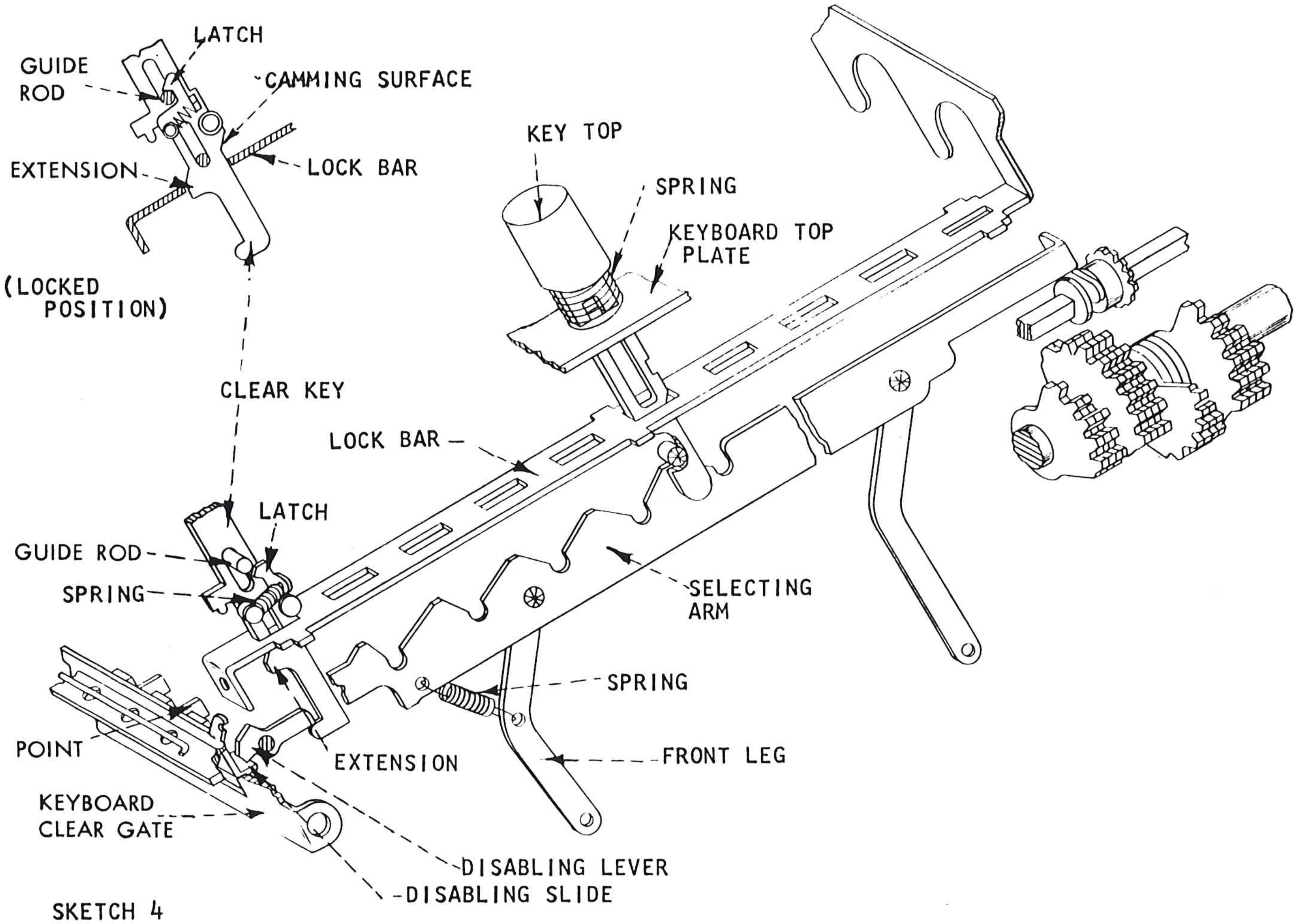


SKETCH 3

Refer to Sketch 3. The depression of the 1st column number 5 selecting key will cause the stud on the key to cam the selecting arm forward. This moves the selecting gear into position so it can be contacted by the number 5 segment tooth of the rear section when the actuator rotates. Depress other keys and notice the same action occurs except that the selecting gears will be positioned differently.

Now, the selecting key must have some means of holding it in place when it is depressed so that the selection can be retained during the calculation. As the selecting key is depressed it cams the key lock bar to the rear, then as the notch in the key aligns with the lock bar the spring moves the lock bar to the front for engagement with the notch. The lock bar now holds the selecting key in the depressed position for retaining the selection. The inset shows the method formerly used for actuating the lock bar. The spring was at the front of the keyboard.

INDIVIDUAL KEY LOCK AND SEPARATE COLUMN CLEAR KEYS:



SKETCH 4

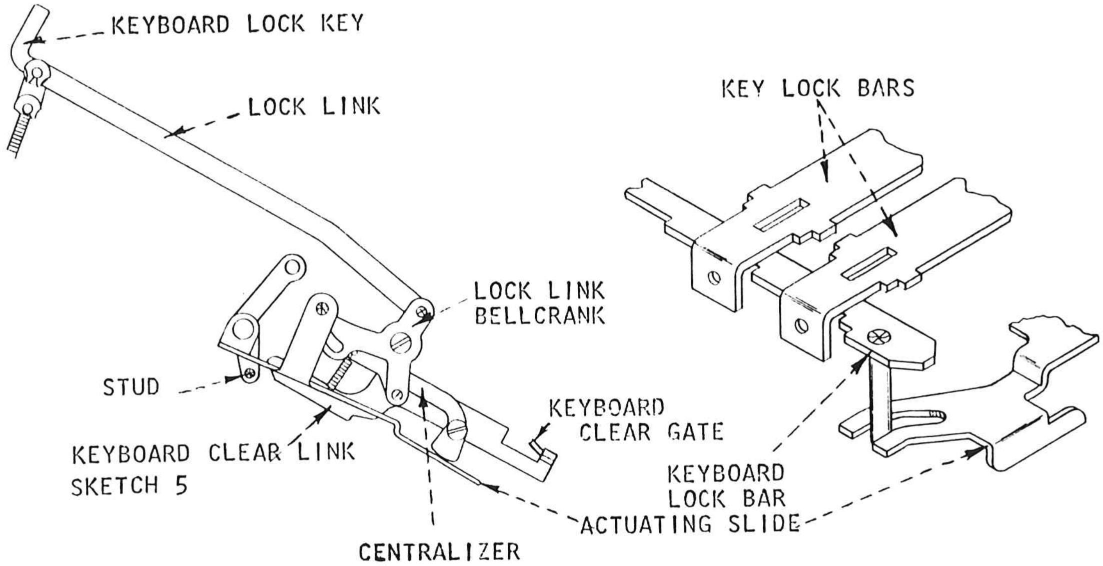
The column clear key not only serves as a separate column lock but also serves as an individual column clear key. The selecting keys in each column can be locked in the depressed position to prevent unintentional release or to retain constant divisors. The selecting keys can also be locked to prevent depression.

The number 5 selecting key that was depressed in the preceding explanation would be locked by pulling upward on the first key in the column. This is the column clear key. The upward motion of the key will position the extension into the lock bar, Sketch 4. This action will keep the lock bar firmly engaged into the notch of the selecting key thus preventing the release of the selecting key. The column clear key is retained in the locked position by the latch. This latch hooks over the key stem guide rod by detent action of its spring.

The upward motion of the column clear key will rock the disabling lever which in turn pulls the disabling slide down and moves the point below the lock bar. This function is necessary for allowing the normal clearing action of the keyboard clear gate.

The depression of the column clear key causes a camming surface to actuate the lock bar rearward and out of the notch of the selecting key. When the lock bar is disengaged from the notch, the spring located under the key top will restore the selecting key. When the selecting key restores, it releases the selecting arm which is restored by the spring on the front leg of the selecting arm. The restoring of the arm moves the selecting gear to the rear and out of alignment with the actuator segments.

KEYBOARD LOCK:



The large keyboard may be locked so that the selection can be retained or so that additional selection cannot be accidentally entered.

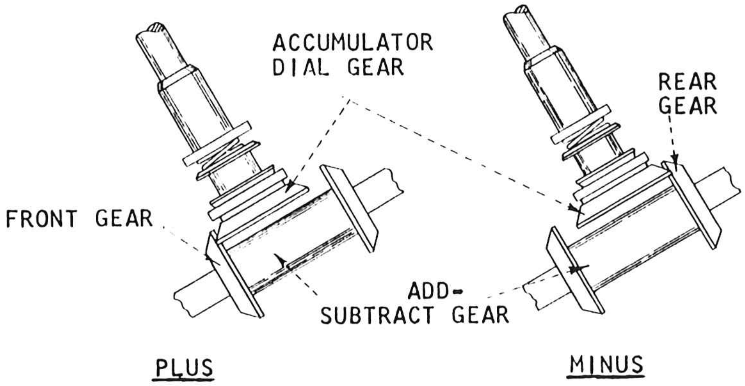
Sketch 5. Pulling the keyboard lock key forward actuates the lock link which causes the lock link bellcrank to move the lock actuating slide forward. The yoke end of the lock actuating slide moves the keyboard lock bar to the right. This action locks all key stem lock bars from rearward movement which prevents the depression of a selecting key. The centralizer keeps the parts in either position.

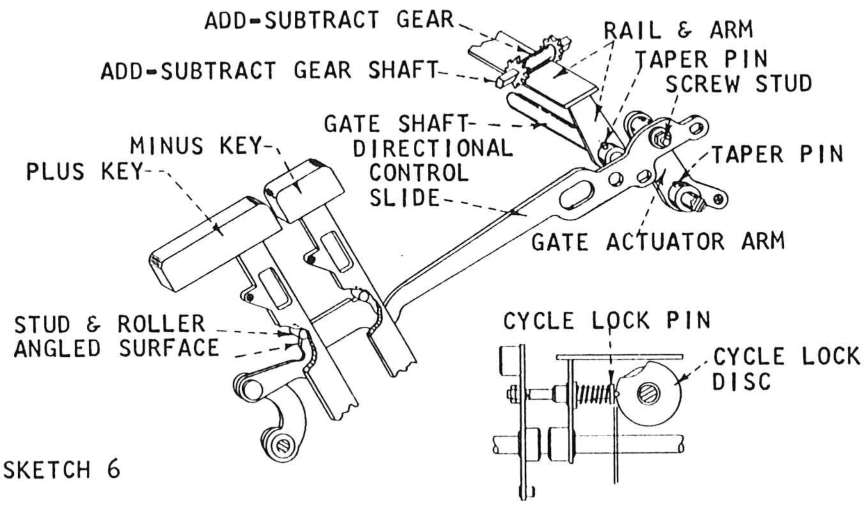
When the actuating slide moves forward, the stud contacts the keyboard clear link and lowers the front end below the keyboard clear gate. This prevents the clear link from contacting the keyboard clear gate when the add key is forward.

MESHING OF ADD-SUBTRACT GEARS WITH ACCUMULATOR DIALS:

For an accumulator dial to rotate, there must be a part that engages with the dial before the machine cycles.

Depress a selecting key and depress the plus key. Rotate the drive shaft by hand crank. Observe that the accumulator dial (Upper dials) rotates in line with the depressed selection key.





SKETCH 6

(a) Trace the sequence of parts that place the add-subtract gate into the plus position, Sketch 6.

Depression of the plus key will cause the stud and roller on the key stem to contact the angled surface of the directional control slide. This will move the directional control slide to the rear and since the slide is connected to the add-subtract gate actuator arm by a screw stud and the gate actuator arm is pinned to the gate shaft, the gate shaft will rotate. The rotation of the shaft will cause the rail and arm to move because they are pinned to the shaft. The add-subtract gear being in contact with the rail will move along the add-subtract gear shaft. This action will bring the front gear of all add-subtract gears into mesh with their corresponding accumulator dial gears.

(b) Depress the minus key. Trace the sequence of parts that place the add-subtract gate into the subtract position.

The depression of the minus key will cause a reverse action of the above parts which brings the rear gear of all add-subtract gears into mesh with their corresponding accumulator dial gears.

CYCLE LOCK PIN:

At the right end of the add-subtract gate and extending through the side frame is the cycle lock pin. This pin is to engage either side of the cycle lock disc which is located on the end of the number 1 actuator. The purpose of the pin and the disc is to hold the add-subtract gate and gears into mesh with the accumulator dials for the completion of an entry cycle to allow the left accumulator dials to complete their rotation. The reason being that the operating keys or gate control levers that initially set the gate are restored before the cycle is completed.

TRANSFER:

The calculator has a means of accomplishing a transfer for the accumulator dials. This is a simplified means due to the Roto-Flow Drive principle construction of the calculator. The transfer from one dial to another is necessary since the maximum figure that can be registered in any dial is 9. If a 9 is registered in a dial and 1 is added thus making 10, the dial showing the 9 will turn to a 0 and the next one to the left registers 1.

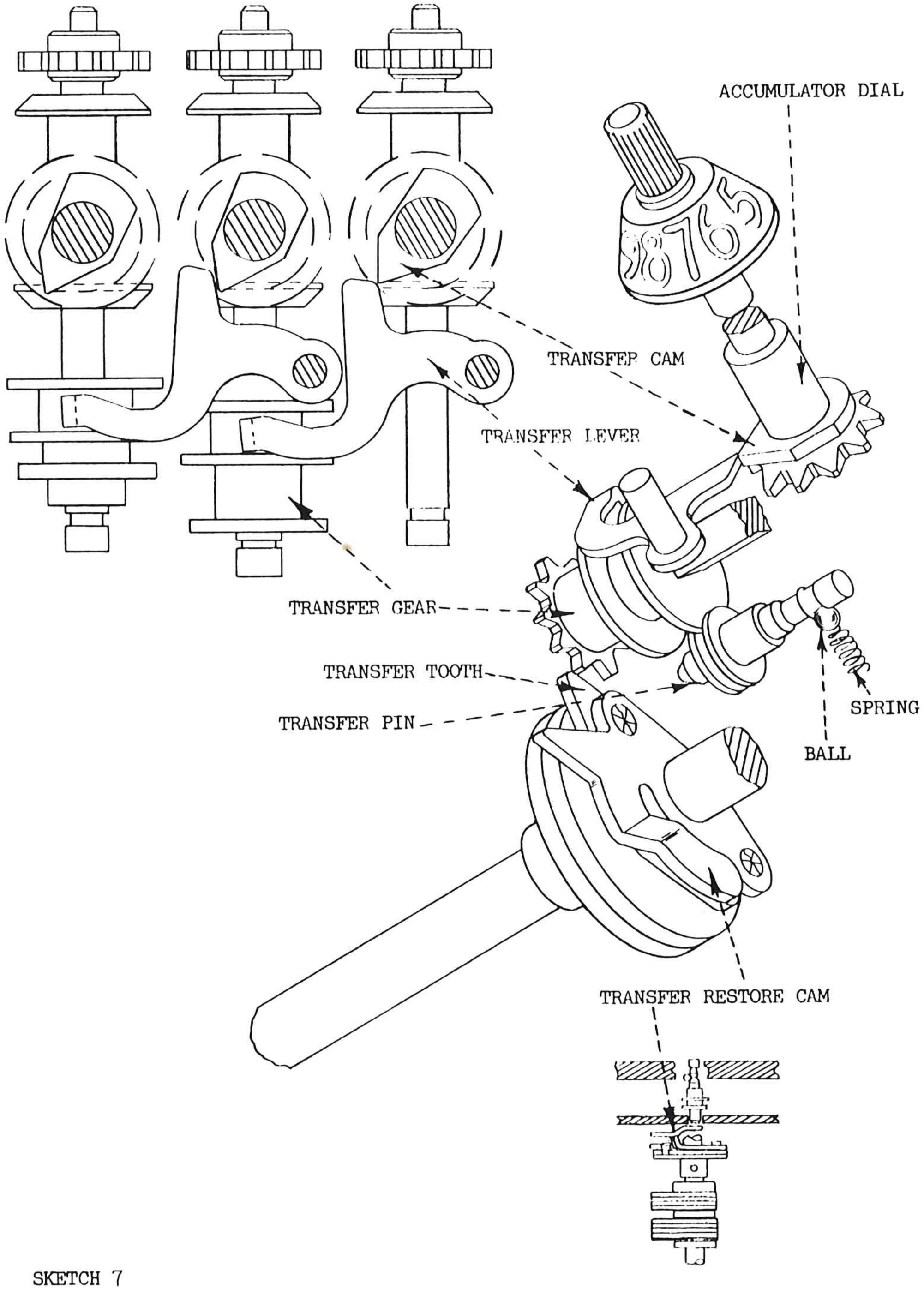
To demonstrate the transfer, clear all accumulator dials to 0 and move the add key forward. Place a 9 in the first keyboard column and depress the plus key. Rotate the hand crank. The dial in line with the 9 selection key will rotate counter-clockwise from 0 to 9. Next, place a 1 in the same keyboard column, depress the plus key and turn the hand crank. Observe the dial showing the 9 will rotate counter-clockwise to a 0, and the dial to the left rotates counter-clockwise from 0 to 1 thus indicating a transfer has occurred. Trace the parts involved that cause the transfer: Sketch 7. The rotation of the accumulator dial from 0 to 9 will bring the transfer cam along side the transfer lever. When the 1 is added, the dial will turn to 0. As the dial turns, the transfer cam trips the transfer lever. The transfer lever being extended to the left will push the transfer gear down in the next column to the left. The transfer gear is pushed down in advance of the transfer tooth rotation. As the transfer tooth contacts the teeth of the transfer gear, the gear will be rotated. Because the gear is fitted over the add-subtract gear shaft, the shaft is turned and since the add-subtract gear is on the shaft and the gear is in mesh with the dial gear, the dial is turned one tooth space. This dial will register 1, and the right dial will register 0.

The transfer also occurs on a minus or subtract operation. Leave the 10 in the accumulator dials and place a 1 in the keyboard column in line with the 0 of the 10. Depress the minus key and turn the hand crank. Observe that the dial showing the 0 rotates clockwise from 0 to 9 and the dial showing the 1 rotates clockwise from the 1 to 0. The dial reverses its direction of rotation from plus to minus, but the parts causing the rotation continue to rotate in one direction.

To further demonstrate the transfer action, clear the carriage and shift the carriage to the extreme left. Place a 1 in the first keyboard column, depress the minus key, and turn the hand crank. Observe that the number 1 dial rotates from 0 to 9, then the number 2 dial rotates from 0 to 9, then the number 3 dial rotates from 0 to 9 and so on across the carriage until the cycle is completed. Fourteen of the dials (if the machine is a 10 bank standard machine) will show 9's. The dial rotation is clockwise on the minus operation.

With the previous selected 1 in the first keyboard column, depress the plus key and turn the hand crank. Observe that the number 1 dial rotates from 9 to 0, then the number 2 dial rotates from 9 to 0, then the number 3 dial rotates from 9 to 0, and so on across the carriage until the cycle is completed. The dials that registered 9's now register 0. The dial rotation is counter-clockwise on the plus operation. You will notice that the transfer action progresses from right to left on the minus cycle the same as on the plus cycle. This direction of transfer is always the same and is possible because of the Roto-Flow One Way Drive Principle.

What restores the transfer gear after it has been turned? The transfer restore cam contacts the transfer pin and cams it to the rear. The transfer pin is detented into position by the spring and ball and holds the transfer gear in the restored position.


ACCUMULATOR DIAL
98765
TRANSFER CAM
TRANSFER LEVER
TRANSFER GEAR
TRANSFER TOOTH
TRANSFER PIN
SPRING
BALL
TRANSFER RESTORE CAM

SKETCH 7

GENEVA PURPOSE AND ACTION - AFTER SELECTION:

As mentioned before, the rotating speed of the actuators is 500 RPM. This indicates that the rotation of the accumulator dials is also rapid. Since an accumulator dial is rotated at a rapid rate whether it is rotated 1/10, 3/10, 5/10, or 9/10 of this revolution there must be a mechanical means to stop the dial rotation after the selection is accomplished. This stopping is accomplished by the action of the geneva against the digitation stop of the actuator geneva disc.

Remove the carriage. Depress all 1's in the keyboard. Depress the plus key and rotate the hand crank. Observe that the add-subtract gears, starting from the right to left, begin to rotate one after the other except number 1 and number 2 which start rotating at the same time. This is possible on the number 1 and number 2 due to no transfer into the first position. Try another row of keys in the keyboard.

At the end of the selection gear shaft is the geneva and directly under it is the geneva disc of the actuator. Observe the position of the digitation stop on the geneva disc when the geneva stops rotating.

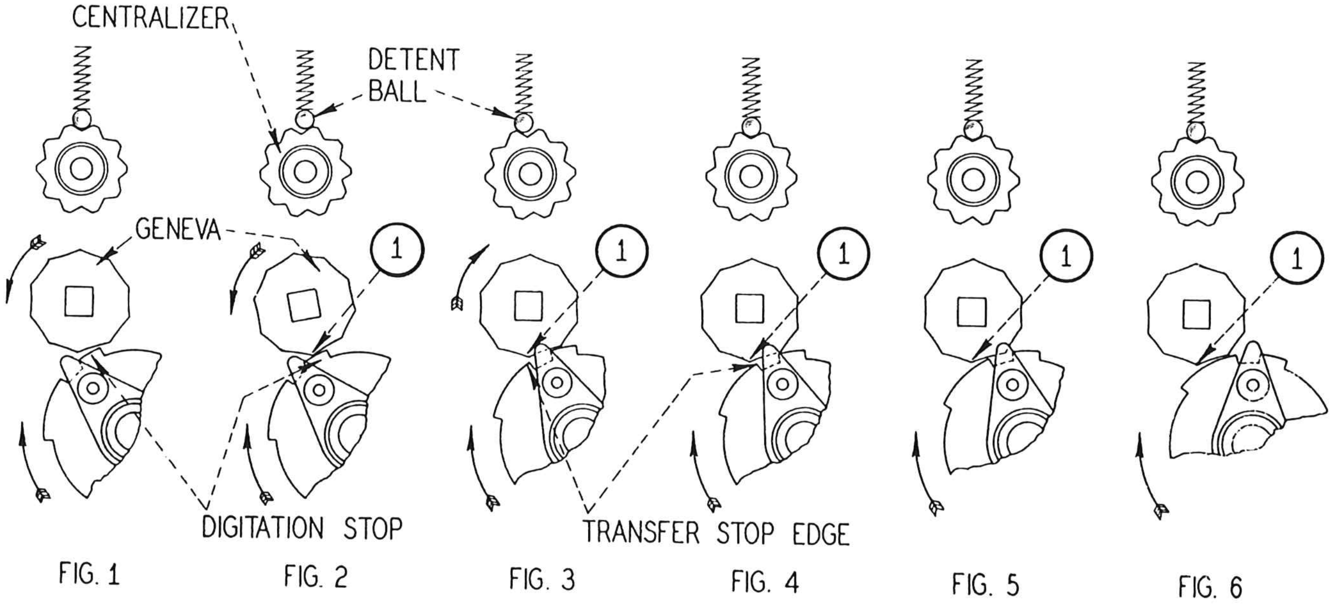


FIG. 1 FIG. 2 FIG. 3 FIG. 4 FIG. 5 FIG. 6

SKETCH 8

(a) What is the purpose and function of the geneva and the digitation stop on the actuator geneva disc?

To assist in understanding the geneva action after digitation, the following explains Sketch 8. Since the geneva is rotated by the action of the actuator segments against the selecting gears (not shown), Fig. 1 shows the geneva as it completes its revolution. The digitation stop has moved under the geneva. As the actuator continues its rotation, Point 1 will rock against the digitation stop, Fig. 2, because of momentum. The digitation stop prevents the geneva from rotating further. The detent ball climbs on the centralizer. The actuator continues its rotation, Fig. 3, and the geneva is rocked back by the detent ball and spring so Point 1 is up and clear of the transfer stop edge. This allows the edge to pass under the geneva without contacting Point 1, Fig. 4. The geneva is centralized and held as the actuator continues its rotation, Figs. 5 and 6. If the geneva clearance is too close or too wide, Point 1 can rock into the edge of the transfer stop and cause the geneva to be turned, thus giving an error. Such action would damage the transfer stop edge.

Notice that the geneva of any column is stopped at the same place regardless of the selection.

GENEVA PURPOSE AND ACTION - AFTER TRANSFER:

Clear the keyboard and pull down a transfer gear. Depress the plus key and rotate the hand crank. Observe the action of the geneva and the position of the transfer stop when the transfer gear rotates.

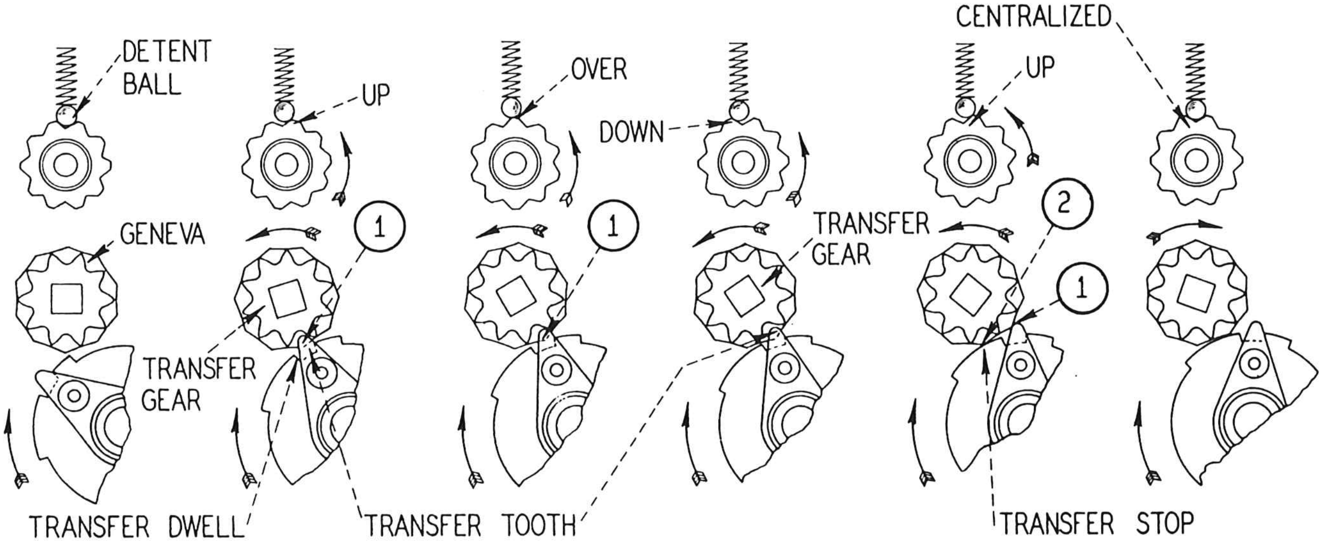
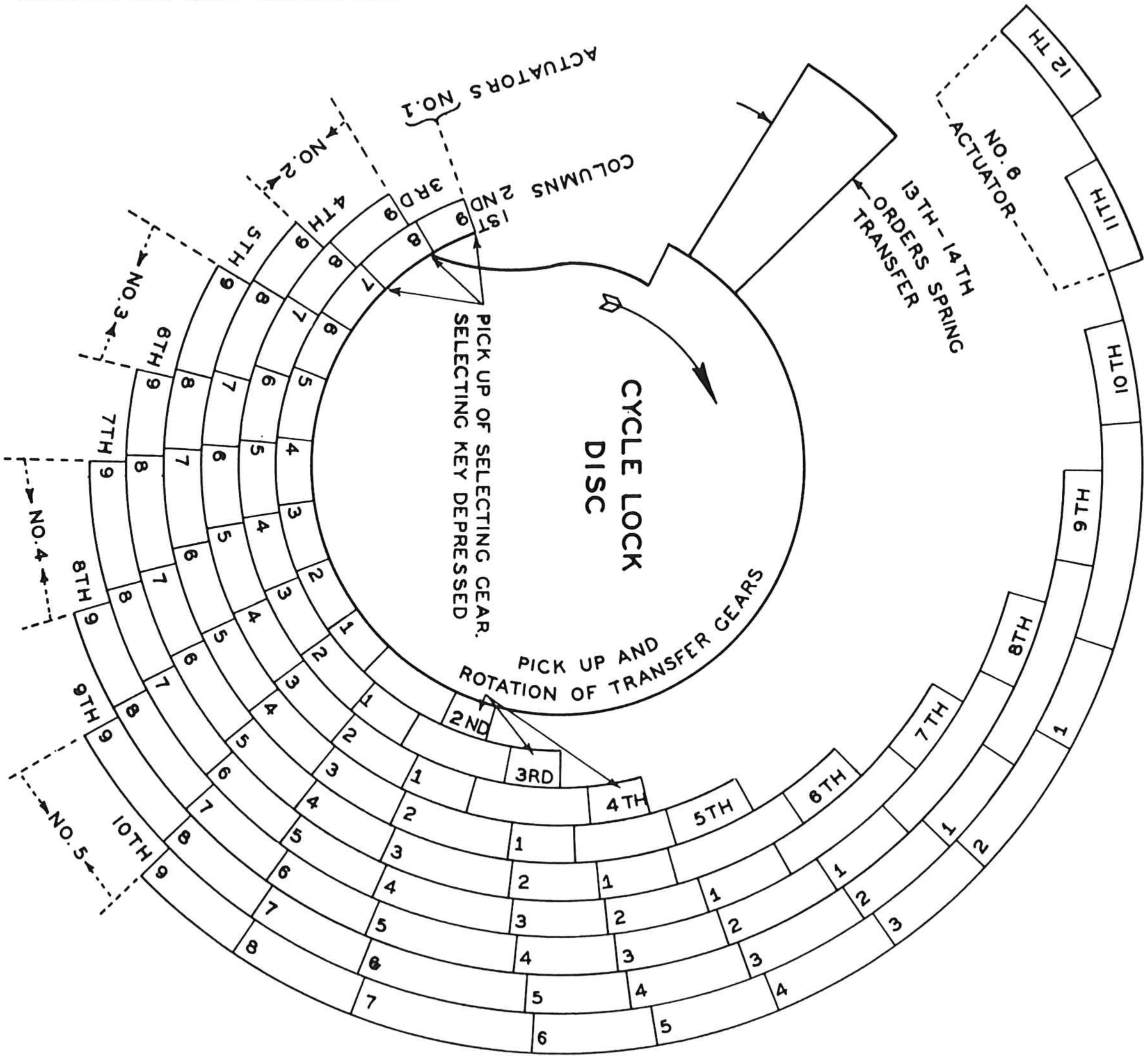


FIG. 1 FIG. 2 FIG. 3 FIG. 4 FIG. 5 FIG. 6

SKETCH 9

To assist in understanding the geneva action after transfer, the following explains Sketch 9. Fig. 1 shows the geneva held steady (no digitation) by the detent ball and spring as the actuator starts to move under it. As the actuator continues to rotate, the transfer tooth contacts the transfer gear teeth and turns the geneva, Fig. 2, so Point 1 is turned in the transfer dwell. The actuator continues to rotate, Fig. 3, and Point 1 is coming out of the transfer dwell. As the transfer tooth leaves the transfer gear teeth, Fig. 4, the geneva, by momentum, rocks down so Point 2, Fig. 5, contacts the transfer stop. This stops the rotation of the geneva and allows only one transfer. The geneva will centralize as the actuator continues its rotation, Fig. 6.

TIMING-SELECTION AND TRANSFER:



SKETCH 10

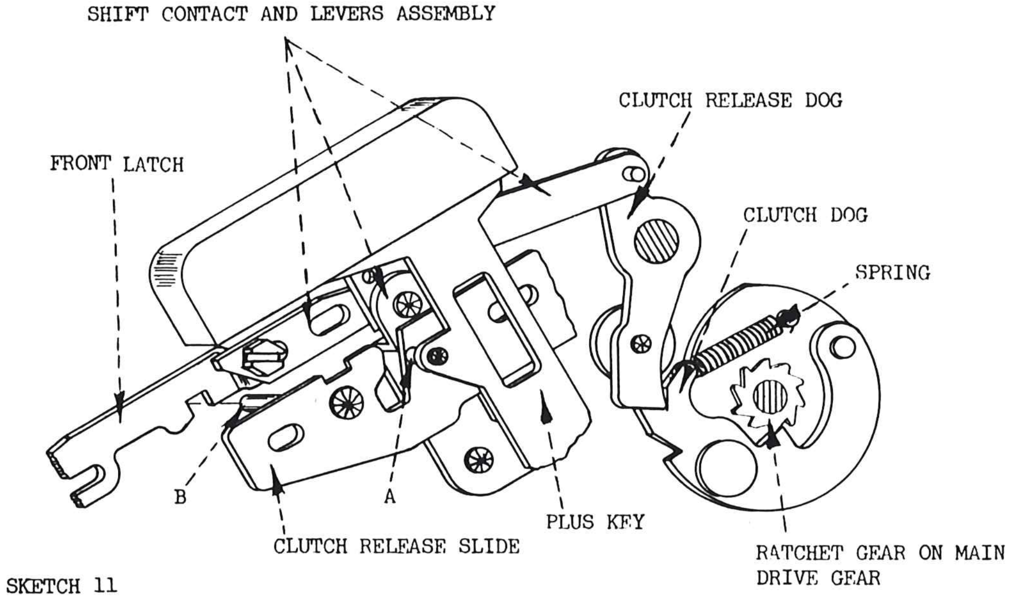
The illustration in Sketch 10 shows the approximate time that selection will pick up on each keyboard column with a selection of 1 through 9. It shows the time of transfer and the time of the spring transfer action. This sketch illustrates these actions during one cycle of the drive shaft.

Place all 9's in the keyboard, depress the minus key and cycle the drive shaft. Notice that the 1st and 2nd columns with a 9 selection starts counting at the same time when the cycle lock disc edge is in line with the cycle lock pin. This simultaneous counting is possible because there is no transfer into the 1st column.

Notice that the 3rd column starts counting before the 4th and the 4th before the 5th and so forth across the machine.

Notice that the transfer starts with the 2nd order transfer gear and progresses across the machine. Notice that the spring transfer action - 13th and 14th orders - occurs just before the cycle lock disc edge moves from contact with the cycle lock pin.

CLUTCH RELEASING - PLUS KEY:

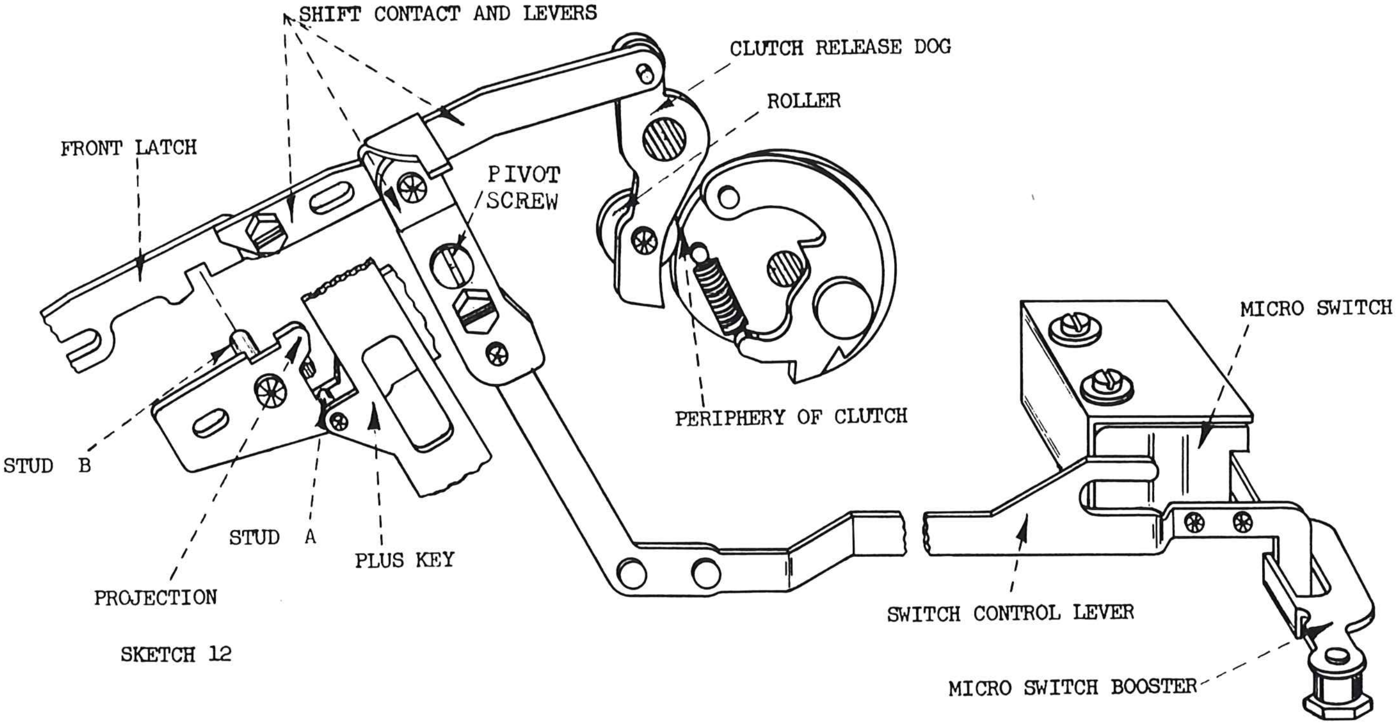


SKETCH 11

Up to this point we have led you through the operations and functions of a few parts. Now we will give you the questions pertaining to the corresponding sketch for you to trace out the answers. Write the answer in a step by step method, describing the operation in your own manner.

Refer to Sketch 11. Depress the plus key and trace the sequence of parts that disengage the clutch release dog from the clutch dog and how the clutch dog engages with the ratchet gear.

SWITCH CLOSING AND LATCHING DOWN OF KEY - PLUS KEY:

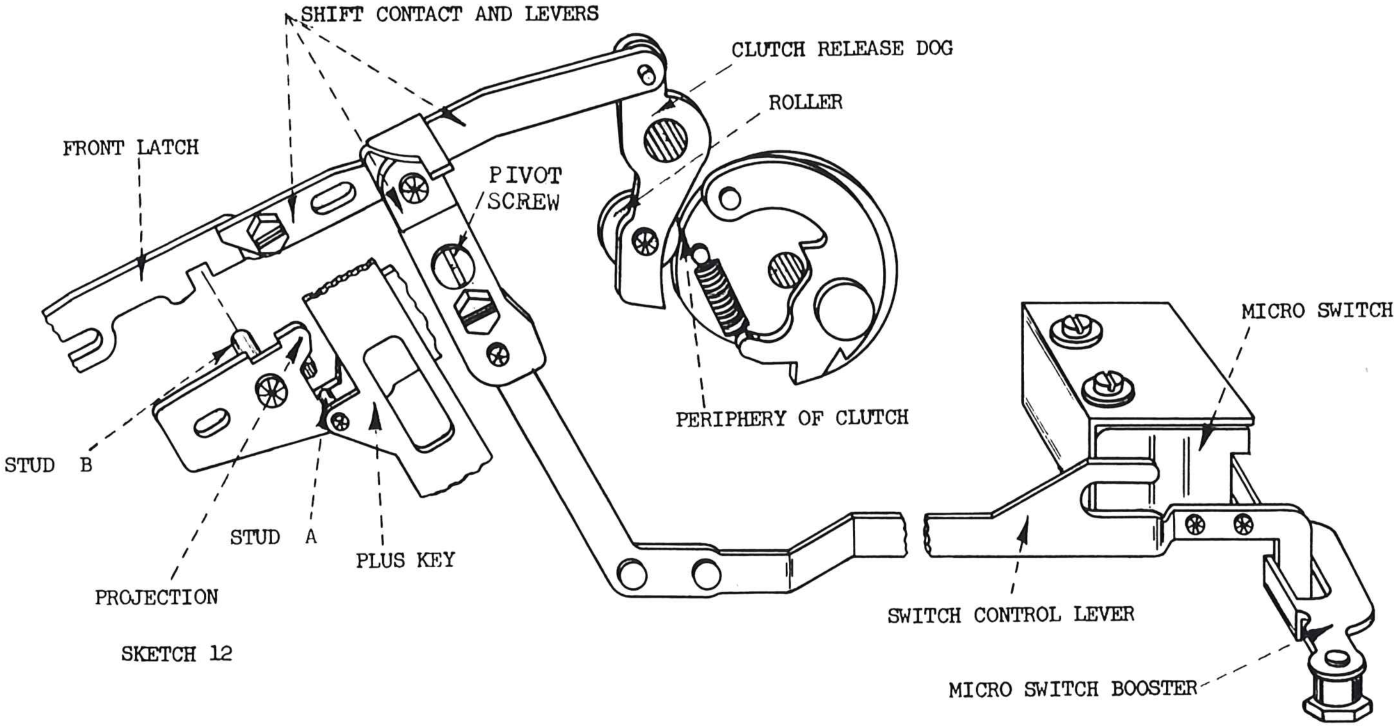


SKETCH 12

(a) Trace and write the sequence of parts that close the micro switch on the depression of the plus key.

(b) How is the plus key latched down when the drive shaft is rotated?

SWITCH CLOSING AND LATCHING DOWN OF KEY - PLUS KEY:

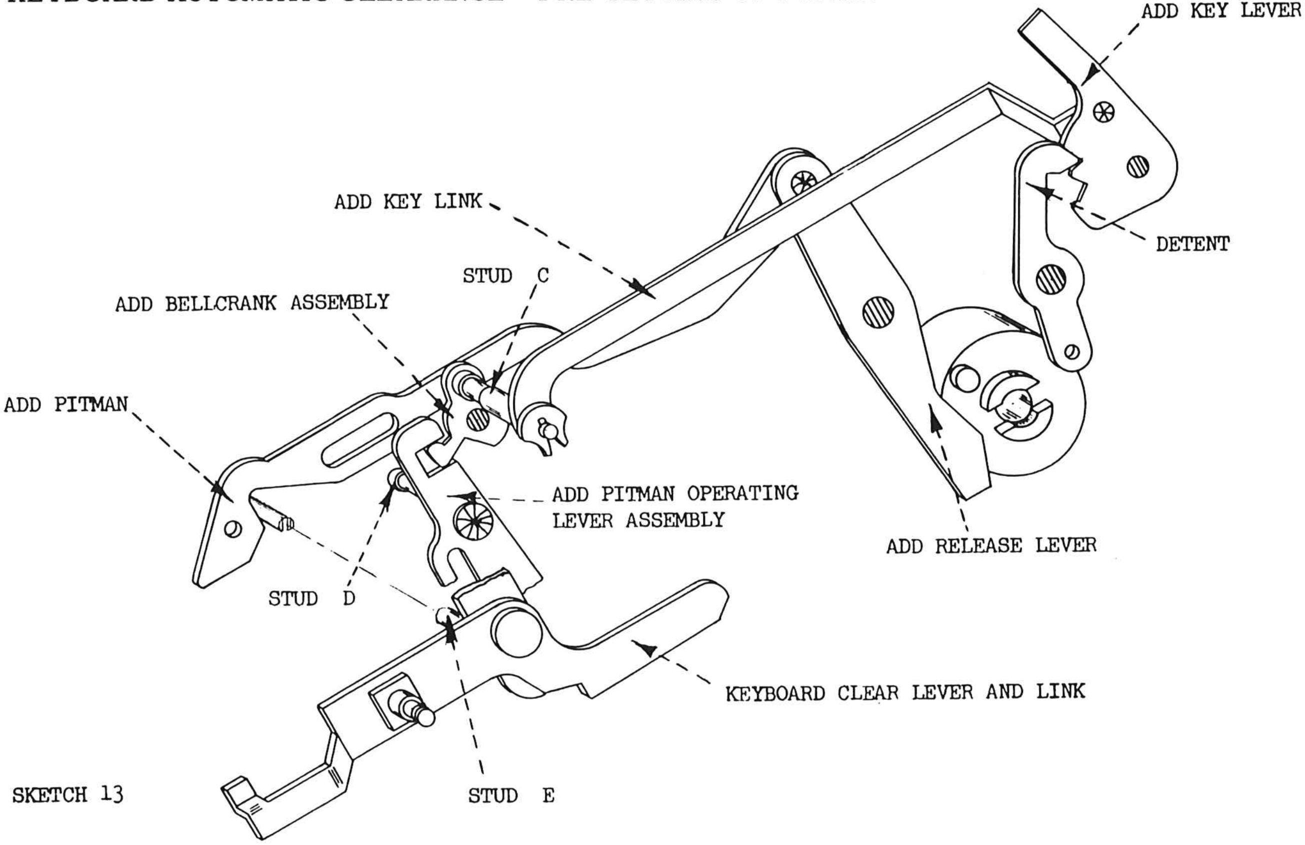


SKETCH 12

(a) Trace and write the sequence of parts that close the micro switch on the depression of the plus key.

(b) How is the plus key latched down when the drive shaft is rotated?

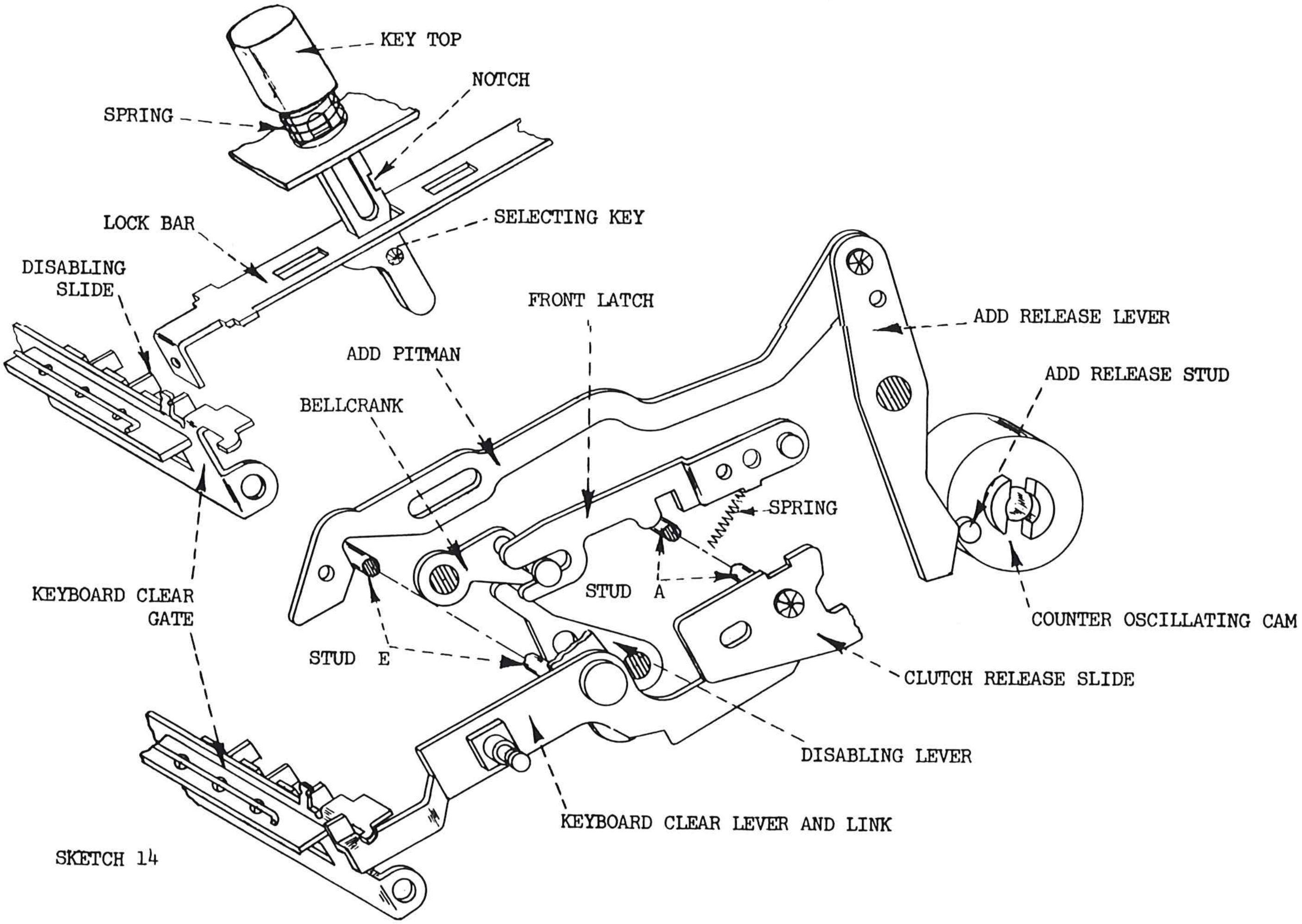
KEYBOARD AUTOMATIC CLEARANCE - PRE-SETTING OF PARTS:



SKETCH 13

Pull the add key down. Trace and write the action and positioning of the parts involved.

AUTOMATIC CLEARANCE - CLEARING OF KEYBOARD AND ONE CYCLE PLUS AND MINUS:



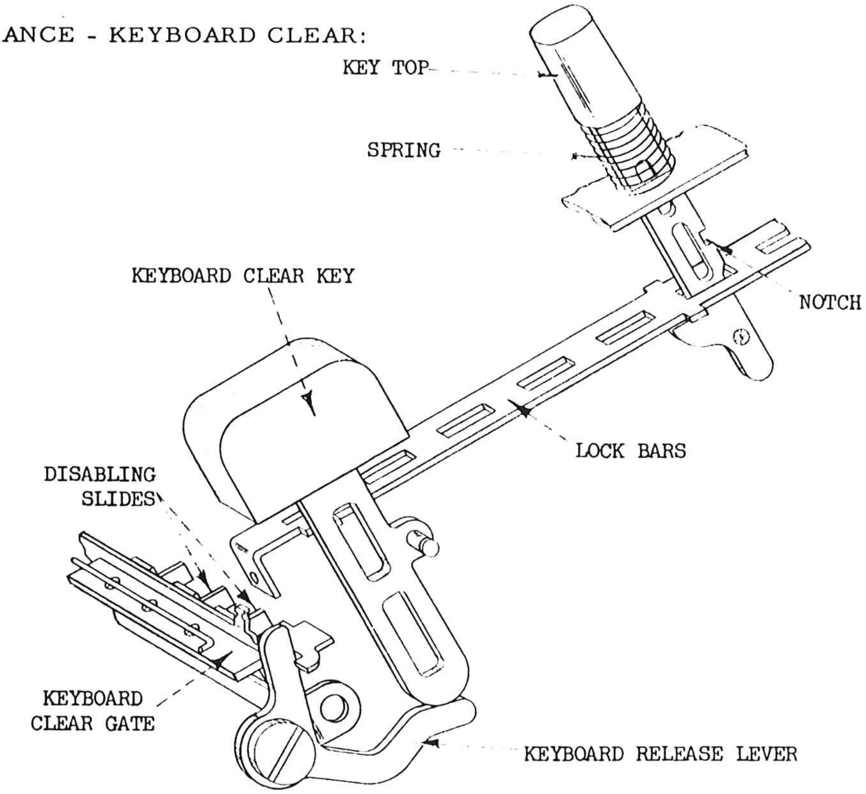
SKETCH 14

Place a selection in the keyboard and depress the plus key. Hold it down. Turn the hand crank and notice that the keyboard will clear near the end of the drive shaft revolution. Also the drive shaft will stop in home position even though you have the plus key held down.

(a) Trace and write the sequence of parts that release the selection key. Sketch 14.

(b) Trace and write how the front latch is allowed to move forward to cause the clutch release dog to engage the clutch dog for stopping the drive shaft rotation. Refer to Sketch 12 also.

MANUAL CLEARANCE - KEYBOARD CLEAR:

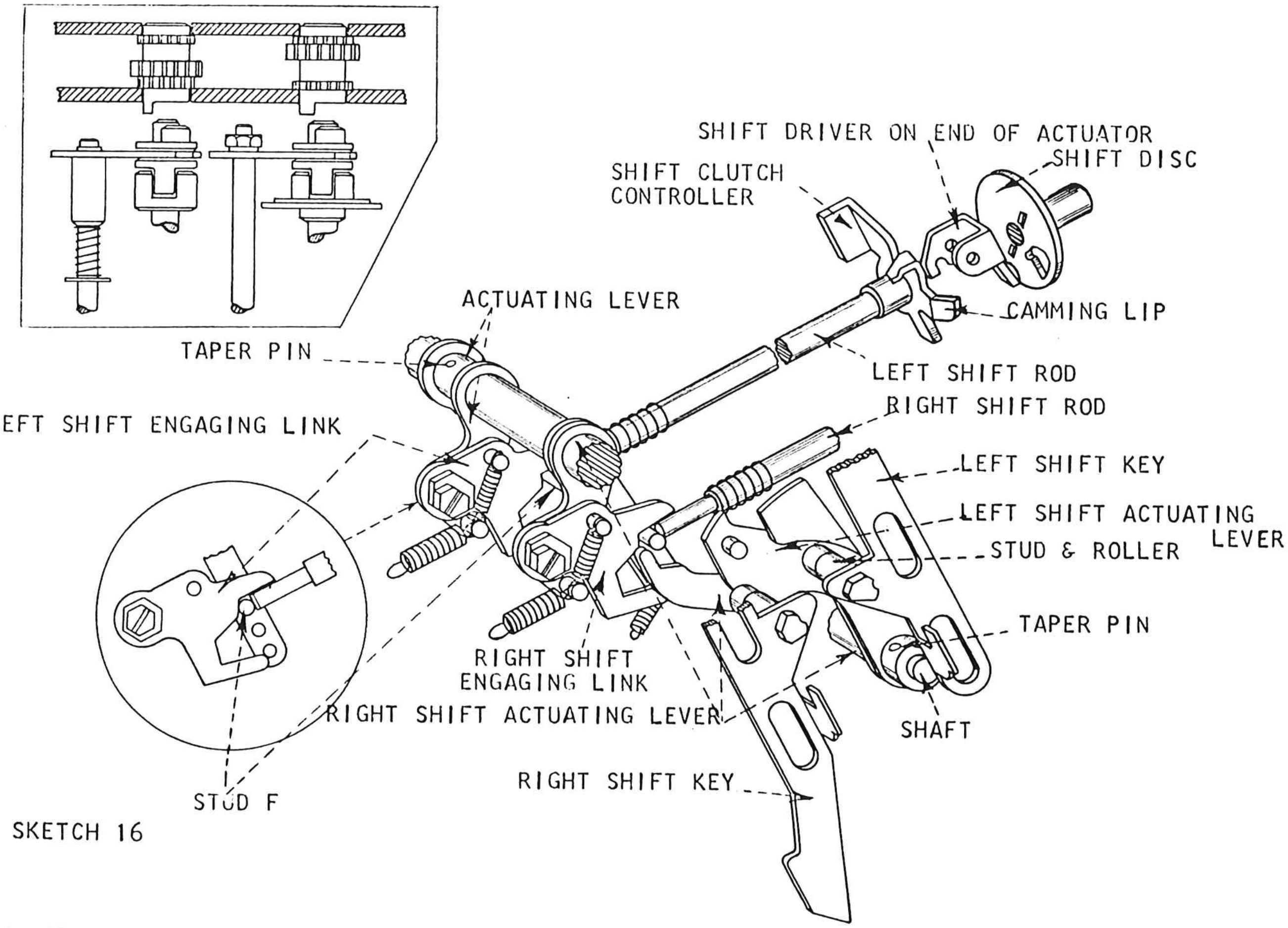


SKETCH 15

The manual release of the entire keyboard is accomplished by the depression of the keyboard clear key, Sketch 15.

The depression of the key actuates the keyboard release lever. The keyboard release lever moves the keyboard clear gate to the rear and brings all the disabling slides into contact with the lock bars. This action moves the lock bars to the rear and out of the notch of any depressed selecting key. The keys restore by the action of the spring located under the key top.

SHIFT KEY DEPRESSION - CARRIAGE SHIFT:



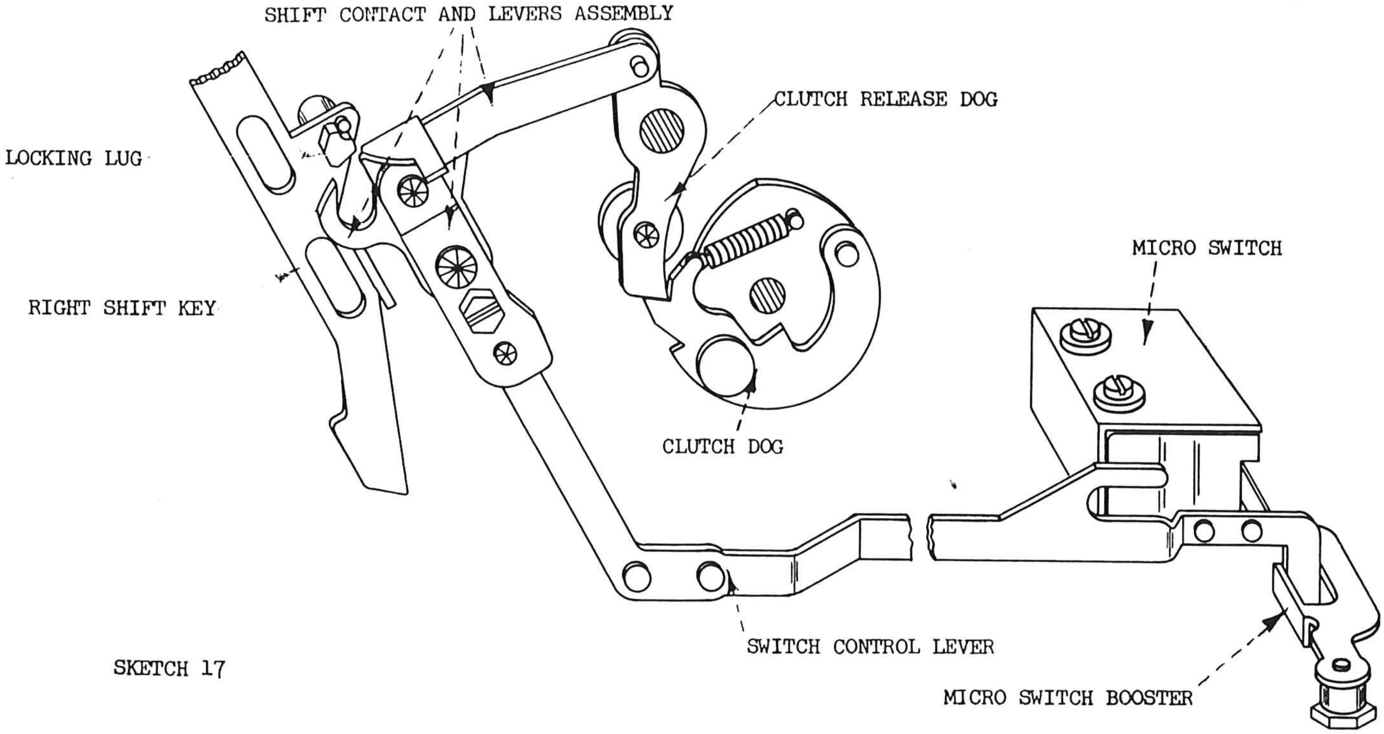
SKETCH 16

(a) (Smooth shift type of shift mechanism.) Depress the left shift key. Trace the sequence of parts that position the shift driver (located on rear of the actuator) into engagement with the Shift Disc, Sketch 16. It will be necessary to rotate the drive shaft after the key is depressed.

(b) Depress the right shift key and trace the similarity in action of the parts.

The inset shows the shift drive gear arrangement found on the two and four point shift mechanisms.

CLUTCH RELEASING - SHIFT KEYS CARRIAGE SHIFT:



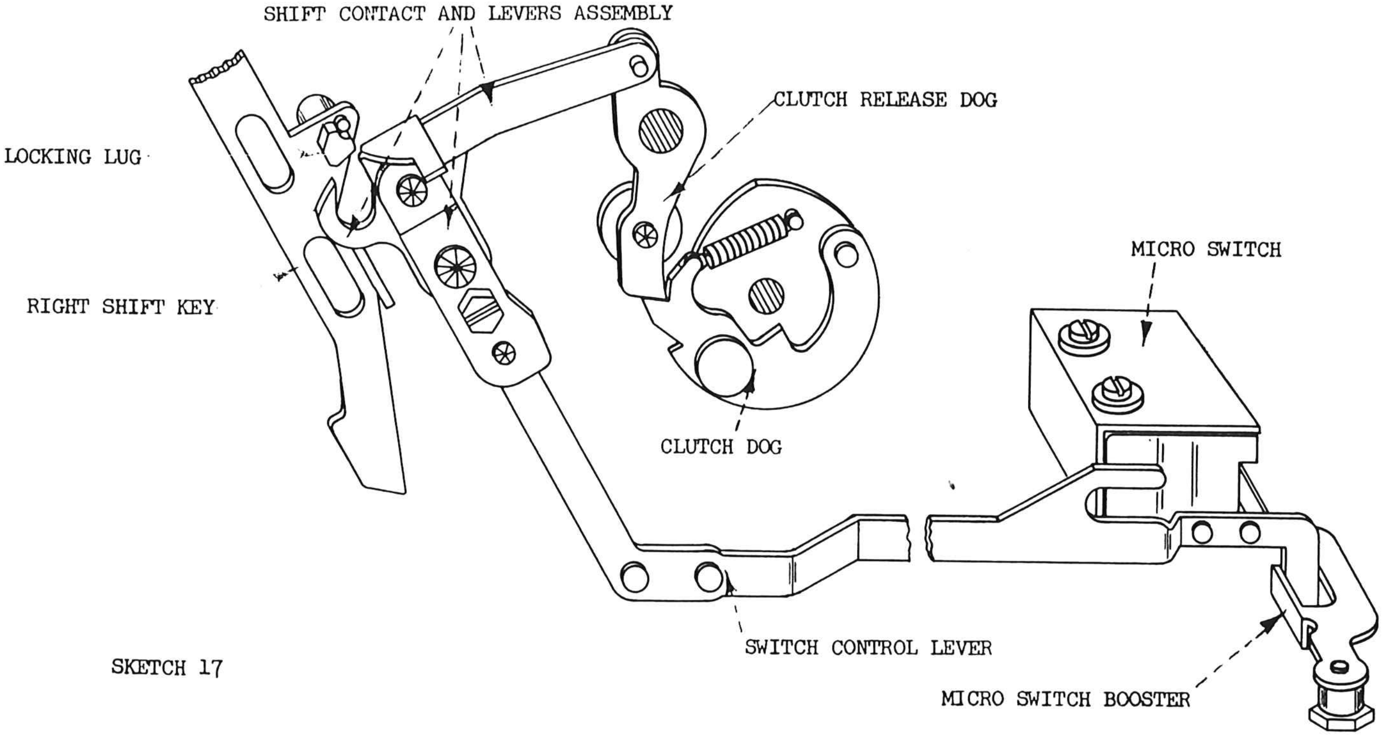
SKETCH 17

(a) Depress either shift key and trace the sequence of parts that move the clutch release dog from the clutch dog, Sketch 17.

(b) What parts cause the micro switch to close?

The keyboard is kept from clearing (add key down) until the carriage clear key restores. This is accomplished by disabling the keyboard clear link below the clear gate. See Sketch 28.

CLUTCH RELEASING - SHIFT KEYS CARRIAGE SHIFT:



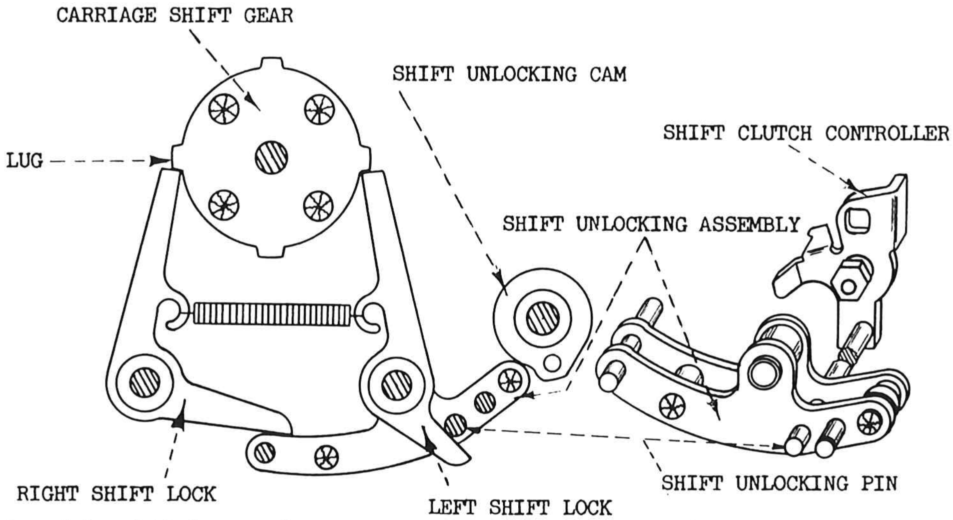
SKETCH 17

(a) Depress either shift key and trace the sequence of parts that move the clutch release dog from the clutch dog, Sketch 17.

(b) What parts cause the micro switch to close?

The keyboard is kept from clearing (add key down) until the carriage clear key restores. This is accomplished by disabling the keyboard clear link below the clear gate. See Sketch 28.

CARRIAGE MOVEMENT - CARRIAGE SHIFT:

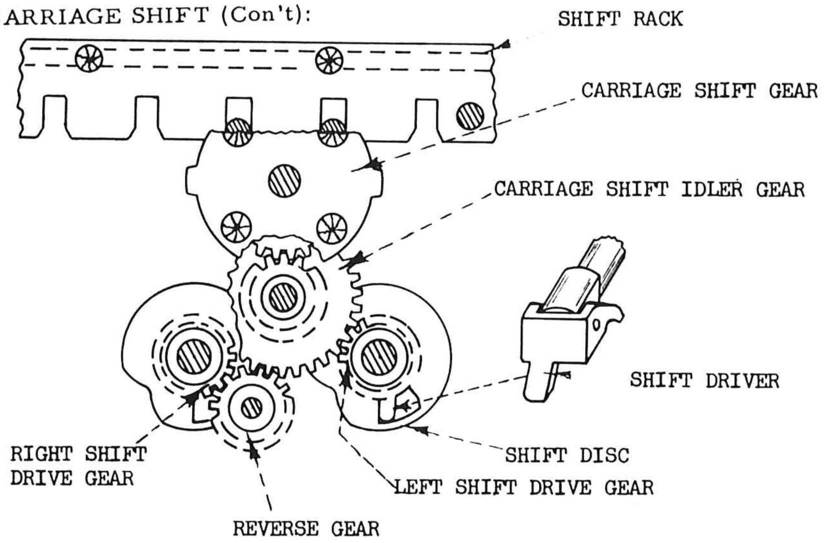


SKETCH 18 A

(a) Depress the right shift key and rotate the drive shaft by hand crank. Notice that the shift locks on the rear bearing plate move from under the lugs on the carriage shift gear before the shift gear rotates. The action of these shift locks is necessary to allow the shift cycle to take place. Trace the sequence of parts that cause the shift locks to be moved from under the lugs of the shift gear,

(b) Trace the sequence of parts on the left shift key.

CARRIAGE MOVEMENT - CARRIAGE SHIFT (Con't):

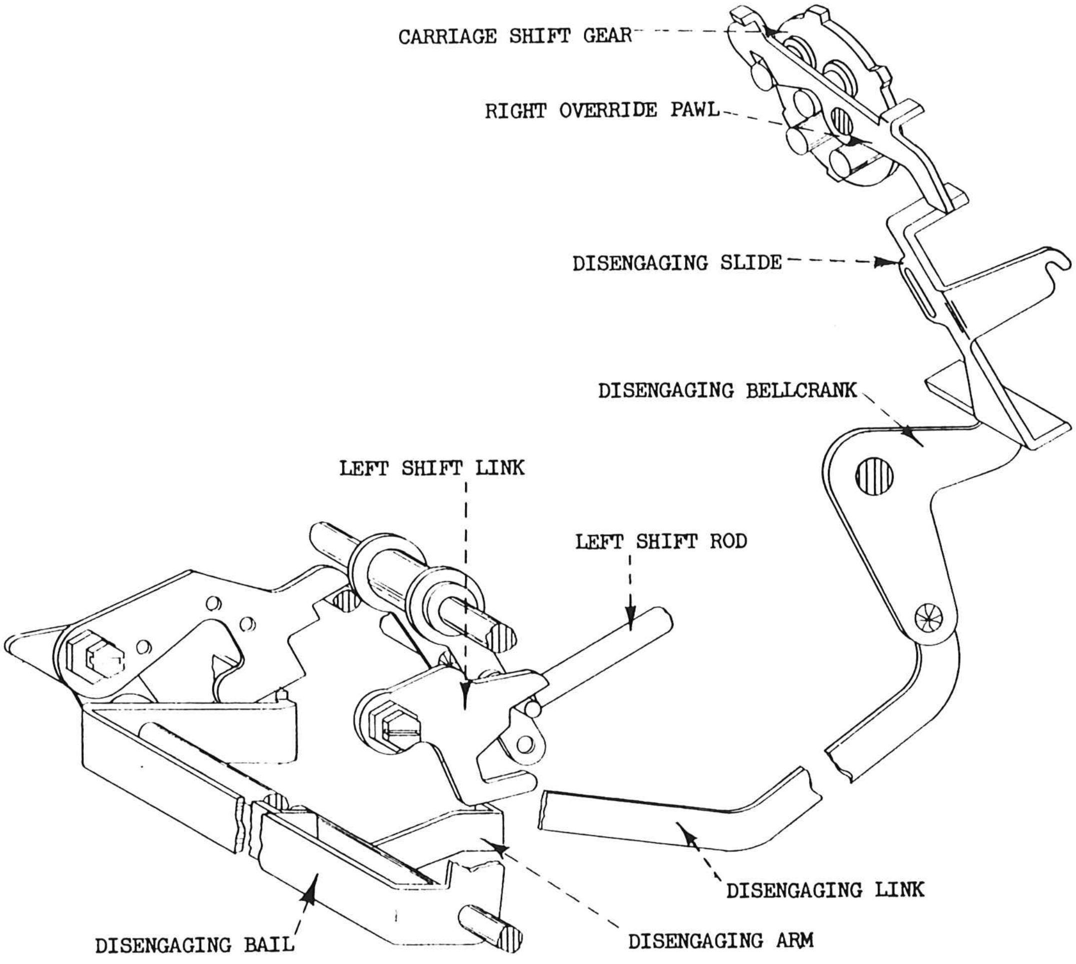


SKETCH 18 B

(c) Trace the sequence of parts that cause the carriage to shift to the right. Start with the engagement of the shift driver to the shift disc then trace the sequence of parts that cause the carriage to shift to the right.

(d) Trace the sequence of parts for left carriage shift.

DISABLING OF LEFT SHIFT AT EXTREME SHIFT POSITION - CARRIAGE SHIFT:

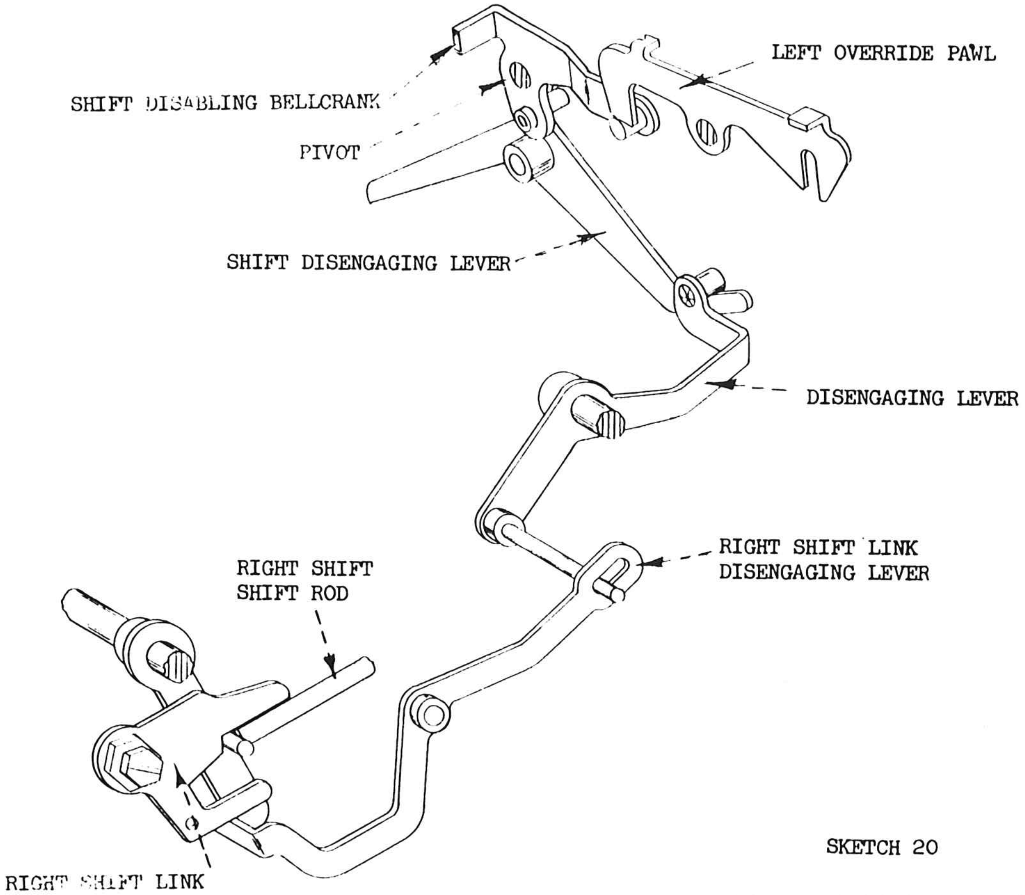


SKETCH 19

When the carriage shifts to the extreme left and the left shift key is held depressed, the carriage shift gear does not continue to rotate, Sketch 19.

The right override pawl depresses the clear disengaging slide. This causes the disengaging bellcrank to actuate the disengaging link, which actuates the disengaging bail to raise the disengaging arm. The formed lip raises the left shift link to allow the left shift rod to restore.

DISABLING OF RIGHT SHIFT AT EXTREME SHIFT POSITION - CARRIAGE SHIFT:

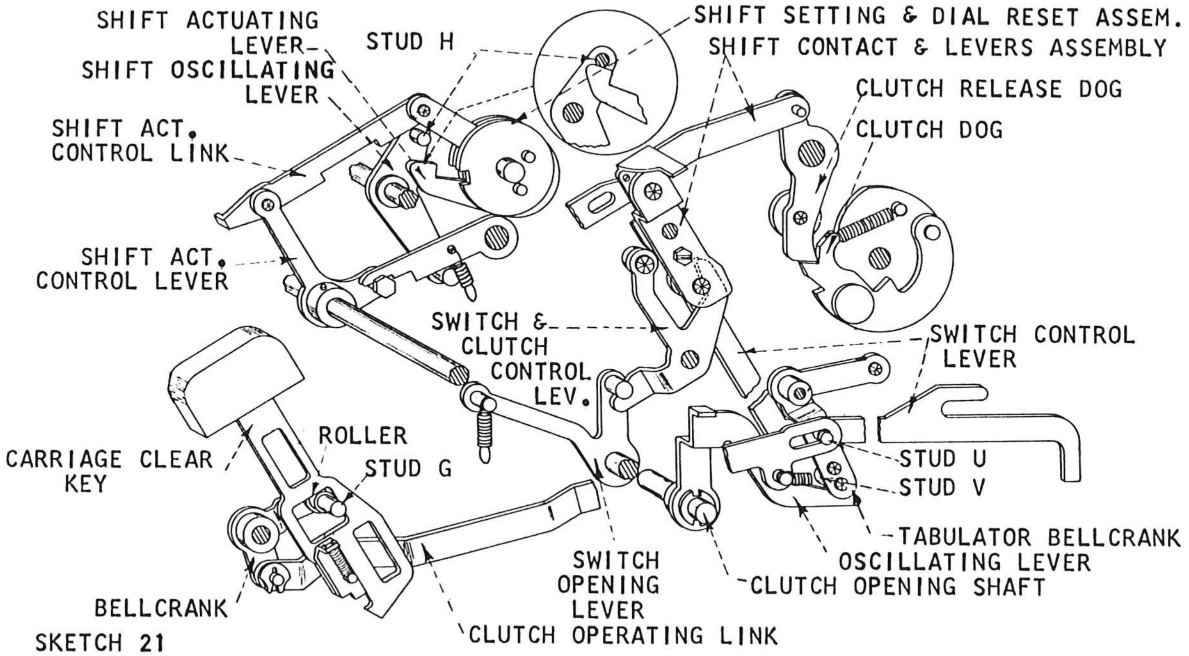


SKETCH 20

When the carriage shifts to the extreme right and the right shift key is held depressed the carriage shift gear does not continue to rotate, Sketch 20.

The left override pawl depresses the shift disabling bellcrank which actuates the shift disabling lever. This lever actuates the disengaging lever to raise the front end of right shift link disengaging lever. The formed lip raises the shift link to allow the right shift rod to restore.

CLUTCH RELEASING AND PRE-SETTING OF SHIFT - CARRIAGE CLEAR:

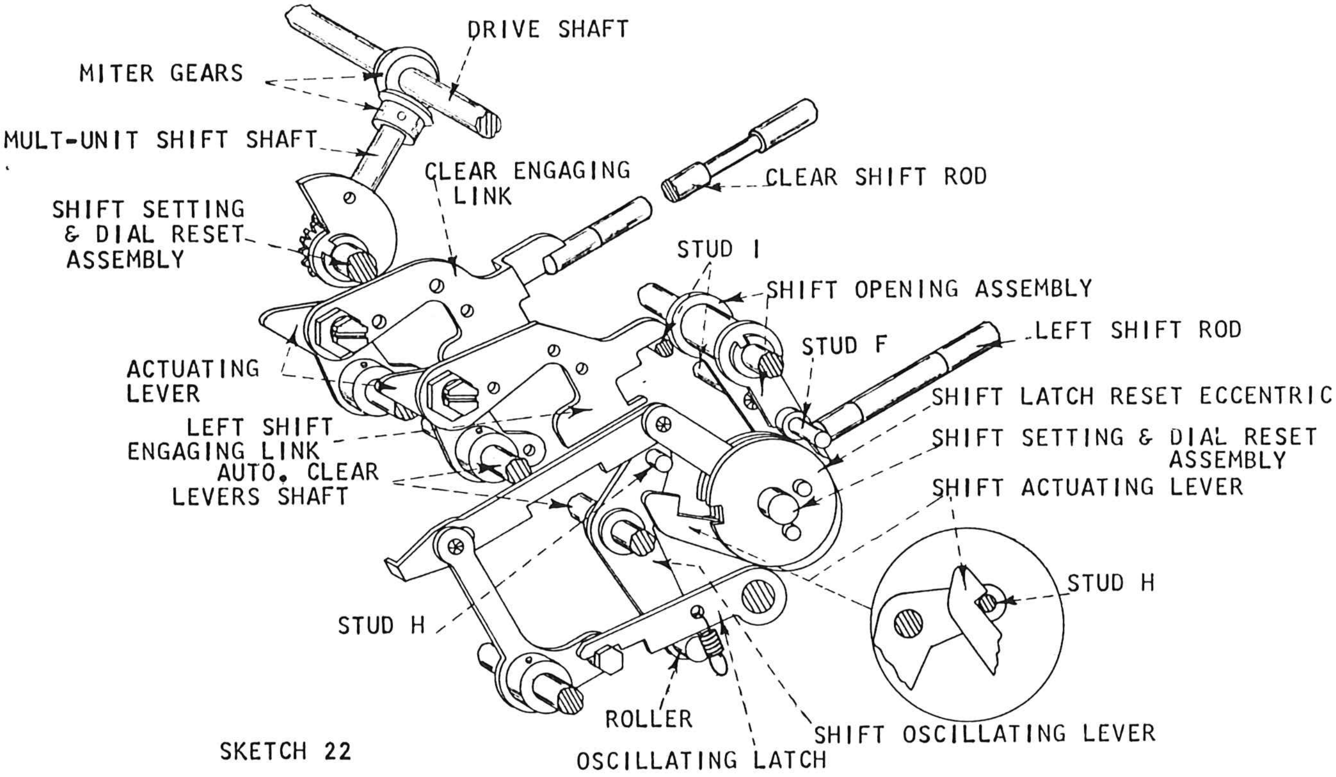


SKETCH 21

(a) Shift the carriage to the extreme right and depress the carriage clear key. Trace the sequence of parts that are actuated to move the clutch release dog from the clutch dog; also how is the micro switch closed? Sketch 21.

(b) With the carriage clear key latched down observe the under side of the machine and rotate the hand crank. Notice that the left shift rod and the automatic clear rod are power-actuated into position on the revolution of the drive shaft. Release the carriage clear key. Re-depress it and trace the sequence of action and parts that pre-set into place for the power setting of the shift rod. Do not rotate the hand crank.

POWER SETTING OF SHIFT - CARRIAGE CLEAR:

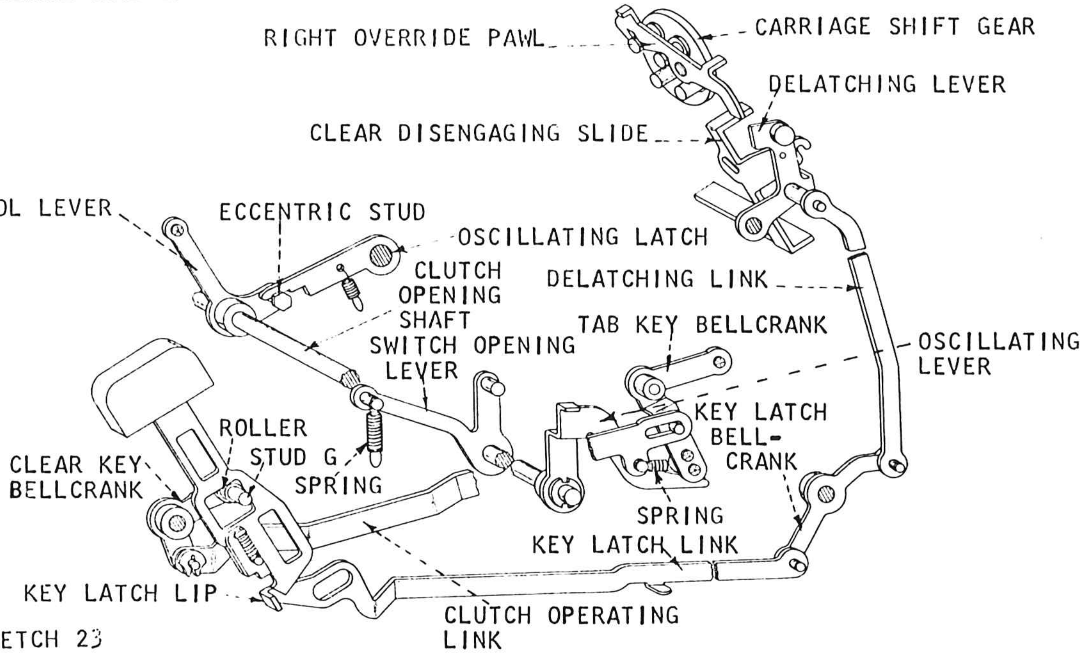


SKETCH 22

(a) Have the carriage clear key latched down. Rotate the hand crank and trace the action of the parts that do the power setting of the shift rods, Sketch 22.

(b) After the shift rods have been actuated into position (to the rear), how are they held there?

KEY RELEASE AND RELEASE OF OSCILLATING LATCH - CARRIAGE CLEAR:



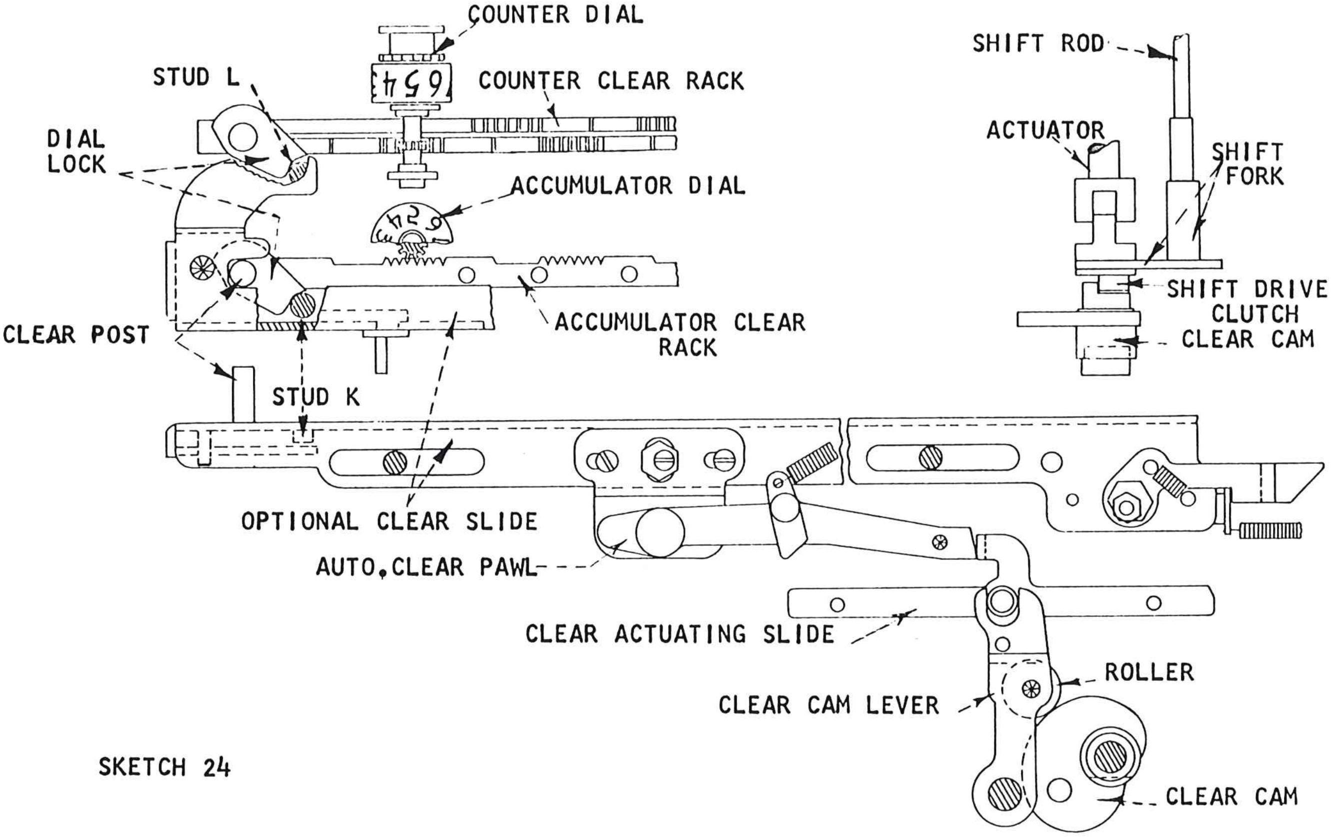
SKETCH 23

(a) When the carriage reaches first position, the carriage clear key is released. Trace the sequence of parts that release the key, Sketch 23.

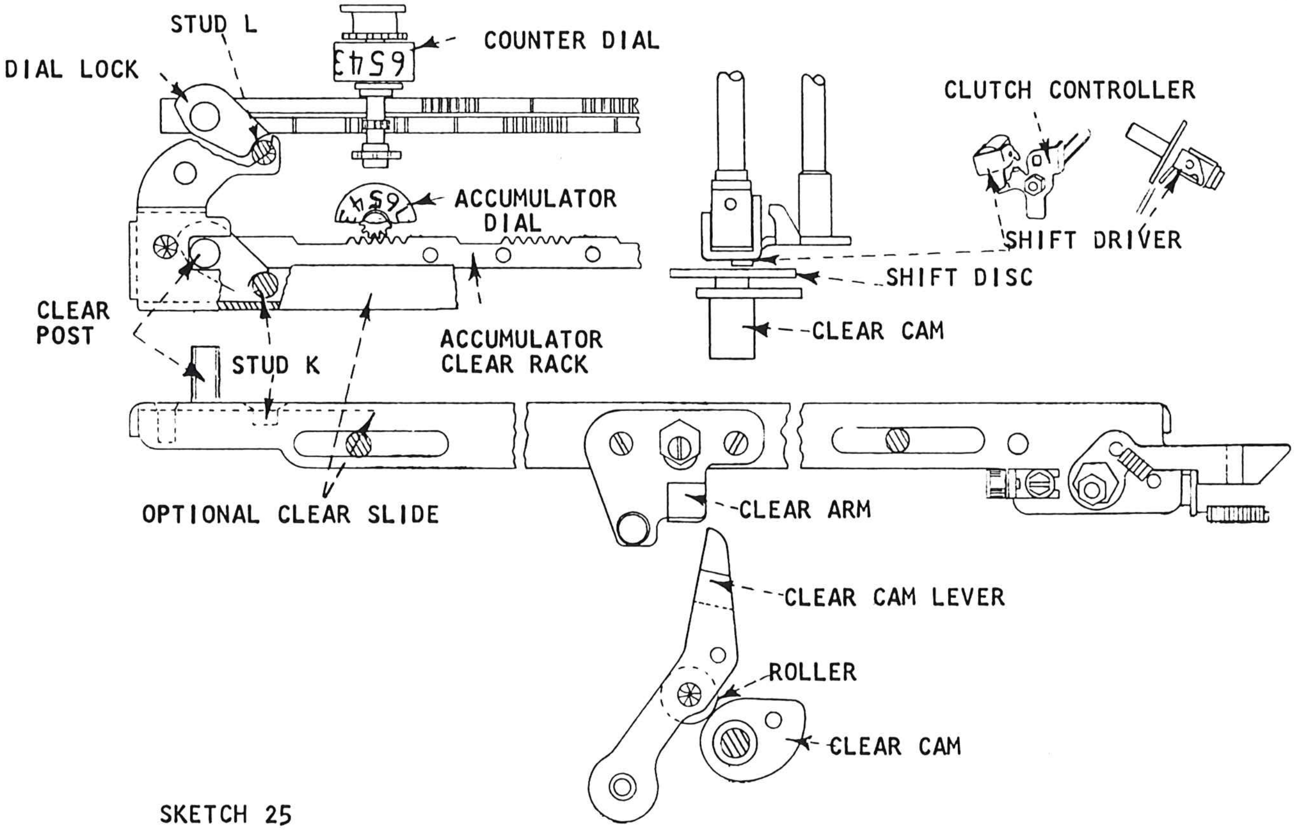
(b) When the carriage clear key restores, how is the Oscillating Latch delatched?

CLEARING OF DIALS - CARRIAGE CLEAR:

(a) Place some figures in the dials. Depress the carriage clear key and rotate the hand crank. Trace the sequence of parts that clear the accumulator dials and the counter dials to 0 when the carriage reaches first position. Sketch 24 shows older style. Sketch 25 shows the revised style.

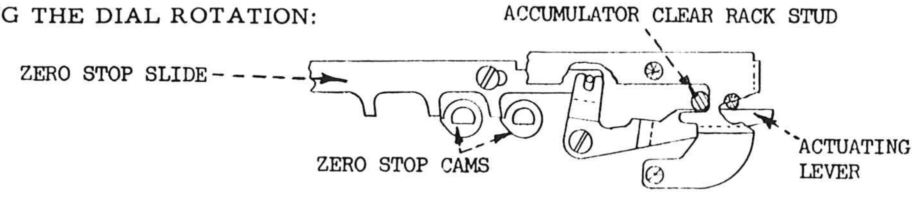


SKETCH 24

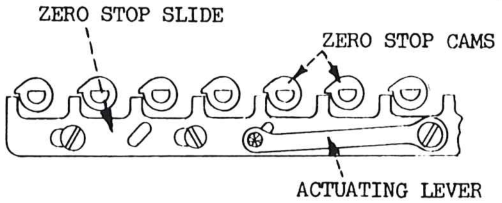


SKETCH 25

STOPPING THE DIAL ROTATION:



ACCUMULATOR DIALS



COUNTER DIALS

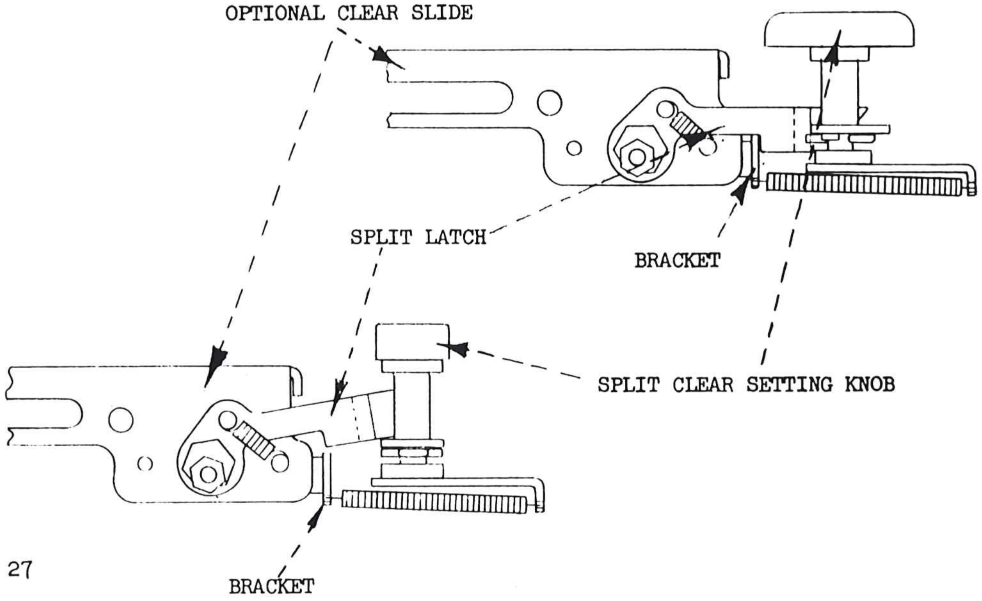
SKETCH 26

Since the dials are rotated to 0 during the clearance action, there must be some means to stop them. This is done by the zero stop slide moving into position so the zero stop cam on each dial will contact it. This action occurs on both the upper and the lower dials.

Place a "1" in the 1st counter dial and slowly pull the clear rack to the right. The dial will turn to 0 and stop against the zero stop slide. Try on other dials with different numbers. The actuating lever causes the zero stop slide to move under the stop cams.

On the accumulator dials, the accumulator clear rack stud causes the actuating lever to pull the zero stop slide to the right and behind the stop cams.

SPLIT CLEARANCE:



SKETCH 27

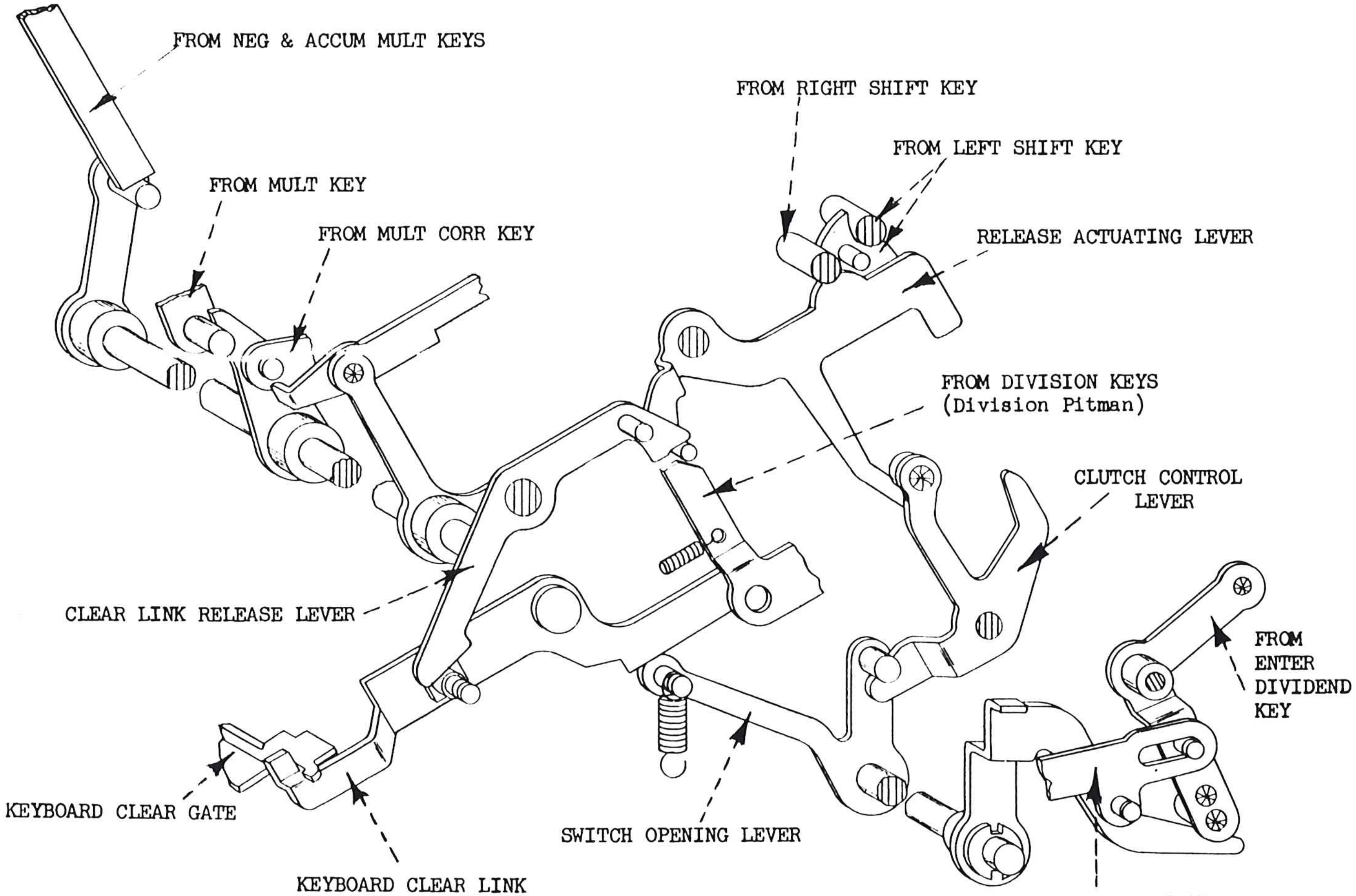
The Model STW, ACG, SRW, CW has a means for clearing the left or the right accumulator dials without clearing the entire set of dials. The carriages are split at the 9th, 8th, or 7th positions. There are some special carriages split at other positions.

The accumulator rack is in two sections. The right hand section being cleared by the optical clear slide actuating the right rack through the dial lock, Sketch 24. The left hand section is controlled by the split latch, Sketch 27.

When the split clear setting knob is parallel with the carriage the split latch is engaged with the bracket. The clearing action of the optional clear slide will cause the split latch to move the bracket to the right. The bracket being attached to the left rack will clear the dials.

When the split clear setting knob is turned, the split latch is raised so the bracket cannot be moved during the optional clear slide movement.

DISABLING OF KEYBOARD CLEAR LINK - CARRIAGE CLEAR:



SKETCH 28

Whenever the clutch opening shaft is operated, the keyboard clear link is depressed below the keyboard clear gate. This is to prevent a keyboard clearance during an operation when the add key is down, Sketch 28. The keys which operate the clutch opening shaft are: Carriage clear, multiply, accumulate multiply, negative multiply, multiply correction (also refer to Sketch 80), and enter dividend.

The keyboard clear link is also depressed by the right and the left shift keys and in division operation.

The keyboard clear link in depressed when the add key is up or down.

DISABLING ON CARRIAGE CLEAR, MULT, ACCUM MULT, NEG MULT, ENTER DIVIDEND:

The switch opening lever actuates the clutch control lever which actuates the release actuating lever. This lever actuates the clear link release lever and depresses the keyboard clear link below the keyboard clear gate.

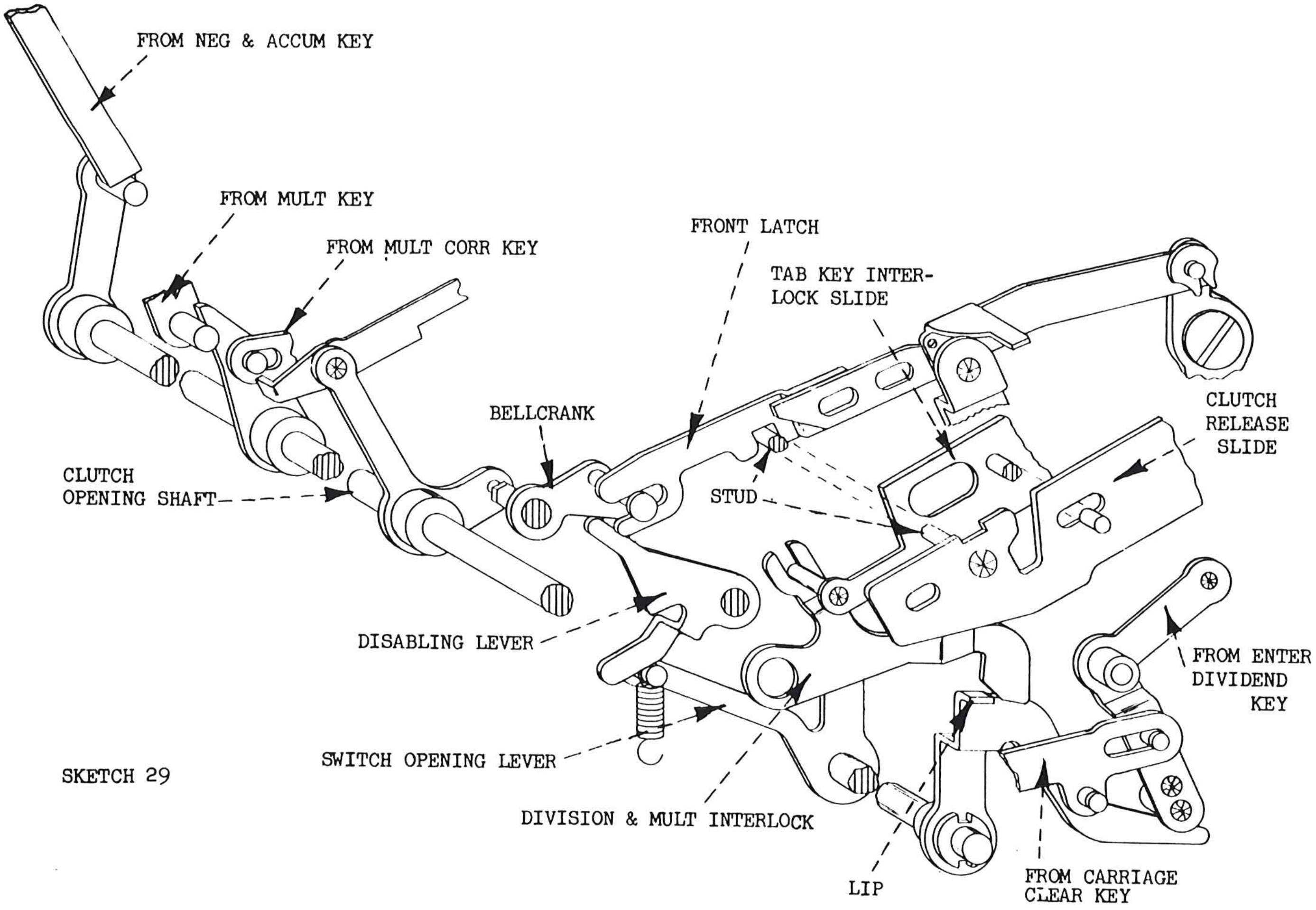
DISABLING FROM THE RIGHT AND THE LEFT SHIFT KEY:

The release actuating lever is actuated to move the clear link release lever which depresses the keyboard clear link below the keyboard clear gate.

DISABLING IN DIVISION:

The division pitman actuates the clear link release lever which depresses the keyboard clear link below the keyboard clear gate.

DISABLING OF DIVISION AND MULT INTERLOCK - CARRIAGE CLEAR:



SKETCH 29

Whenever the clutch opening shaft is operated, the division and mult interlock is disabled from the lip of the actuating lever located on the right end of the clutch opening shaft. The keys that operate this are: Carriage clear, multiply, accumulate multiply, negative multiply, multiply correction, enter dividend, Sketch 29.

The switch opening lever actuates the disabling lever which raises the bellcrank. A stud on the bellcrank raises the front latch so it is clear of the stud on the clutch release slide. As the front latch moves to the rear at the time the clutch release dog releases the clutch dog, it moves over the stud, therefore cannot actuate the clutch release slide, the tabkey interlock slide, and the division and mult interlock.

COUNTER:

Basically the counter is a means of recording each cycle of the drive shaft; therefore, whenever the drive shaft rotates, the #1 primary finger of the counter will engage a counter dial and cause the dial to rotate. At this point of the course we will explain the counter operation for you. Refer to Sketch 30 and to the machine. After this you will have a tracing operation to complete regarding the counter.

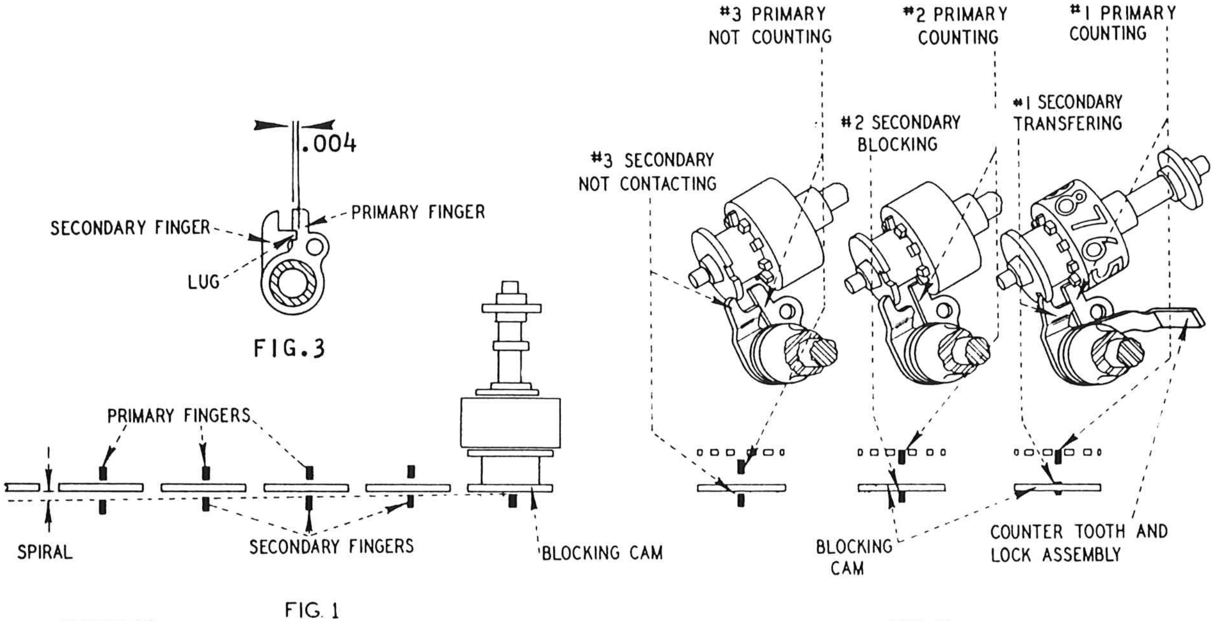


FIG.3

FIG. 1

SKETCH 30

FIG. 2

The counter assembly is composed of a counter carrier and two types of counter fingers.

1 Counter tooth and lock assembly which is assembled in the first position on the right end of the counter carrier. Has one primary finger and a lock.

2 To #9 or #11 counter transfer fingers assembly, depending on whether the counter is for 8 bank or 10 bank machines. Each assembly has one primary finger and one secondary finger.

All counter fingers toward the rear of the machine are known as primary fingers and all counter fingers toward the front of machine are known as secondary fingers. The primary fingers operate the counter dials so we shall call them counting fingers; the secondary fingers contact the blocking cam on the counter dial and prevent the primary fingers engaging the counter gear on the counter dial except when there is a transfer from one dial to the next, so we shall call them blocking fingers.

#1 counter tooth and lock assembly consists of a counting finger and a lever or lock to contact the counter blockout slide which is attached to the add-subtract gate. The counter blockout slide allows the counting fingers to engage the counter dials when the add-subtract gate is in add or subtract position and also prevents the counting fingers engaging the counter dials when the carriage is shifting. The #1 primary finger which we shall call the #1 counter finger, is always in counting position and will operate the counter dial directly in line with it in all operations except carriage shift. (Unless the counter is blocked from operation by the MNE-Multiplier Non Entry Key).

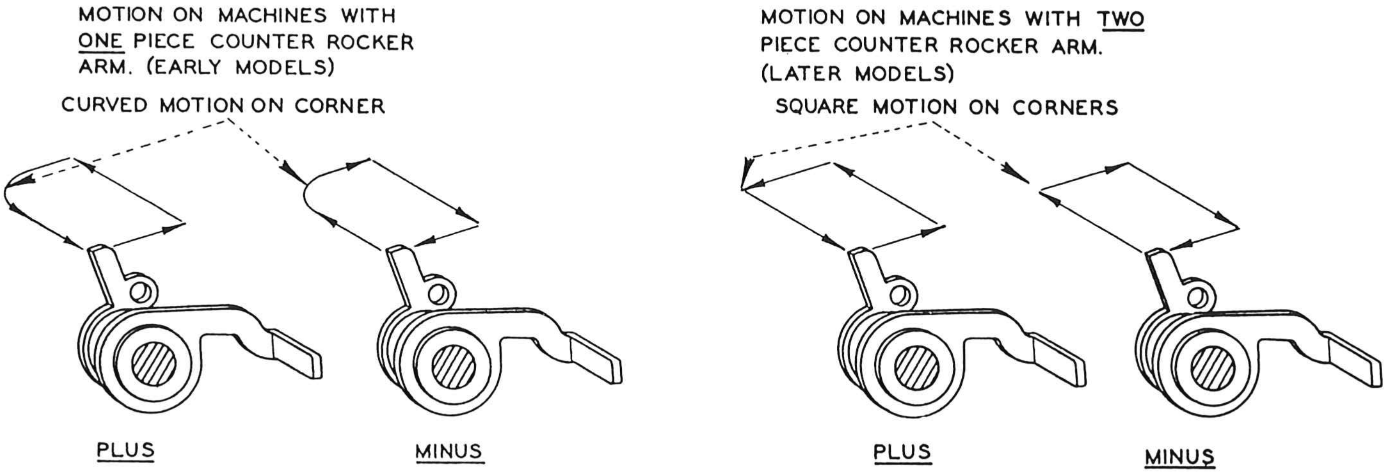
COUNTER (continued)

The counter fingers are so designed that when installed on the counter carrier they are not in a straight line parallel to the counter shaft but in a spiral around it, Fig. 1, Sketch 30. This spiral is very slight, being approximately .004 inch per counter finger and it is very important. When any one of the secondary fingers is blocking on the solid part of the secondary cam, (and there should never be more than one secondary blocking at any time), this spiral prevents any of the remaining secondaries to the left touching the secondary cams, Fig. 2. The spiral is caused by the lug of the secondary overlapping the primary, Fig. 3.

When this spiral is destroyed between any two secondary fingers, the results will be that when the secondary to the left of the one that is blocking is out of line, it will allow the secondary that is out of line to touch the blocking cam on the counter dial directly in front of it thus causing a flicker of the dial, or if there is a 9 in the dial, it may kick over to 0, and we have what is known as a "pickup" or error.

Fig. 2 of Sketch 30 illustrates the transferring action when the dial in line with the #1 primary reaches its capacity. Have the dials at 0, depress the plus key and hold down. Cycle the drive shaft by hand crank for 9 cycles. When the 9 appears in the dial, the notch in the blocking cam is in line with the #1 secondary. The next cycle of the machine will allow the #1 secondary to move through the notch and allow the #2 primary to engage the teeth of its corresponding dial. The #2 secondary contacts the blocking cam of the dial and prevents the #3 primary from engaging the teeth of its dial. The spiral between the #2 and #3 secondary prevent the #3 secondary from contacting the blocking cam.

COUNTER FINGER MOVEMENT:


MOTION ON MACHINES WITH ONE PIECE COUNTER ROCKER ARM. (EARLY MODELS)
CURVED MOTION ON CORNER
PLUS
MINUS
MOTION ON MACHINES WITH TWO PIECE COUNTER ROCKER ARM. (LATER MODELS)
SQUARE MOTION ON CORNERS
PLUS
MINUS

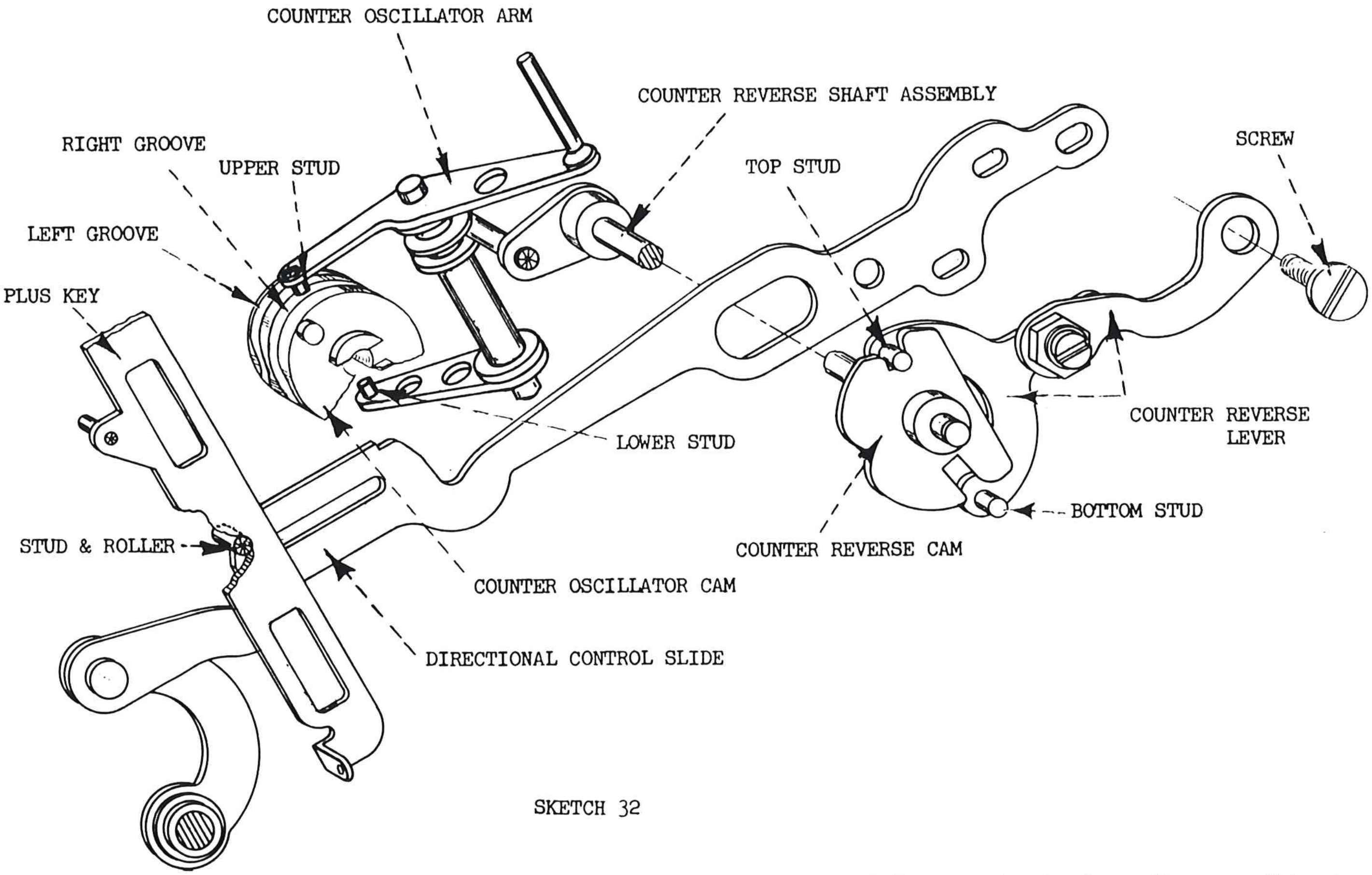
SKETCH 31

The action of the counter is illustrated in Sketch 31 above.

Plus operation: Remove the carriage and observe the #1 primary. Depress the plus key and cycle the drive shaft. The #1 primary moves to the rear, then to the left, then to the front, and to the right to home position.

Minus operation: Depress the minus key and cycle the drive shaft. The #1 primary moves to the left, then to the rear, then to the right, then to the front to home position.

POSITIONING OF COUNTER OSCILLATOR ARM:



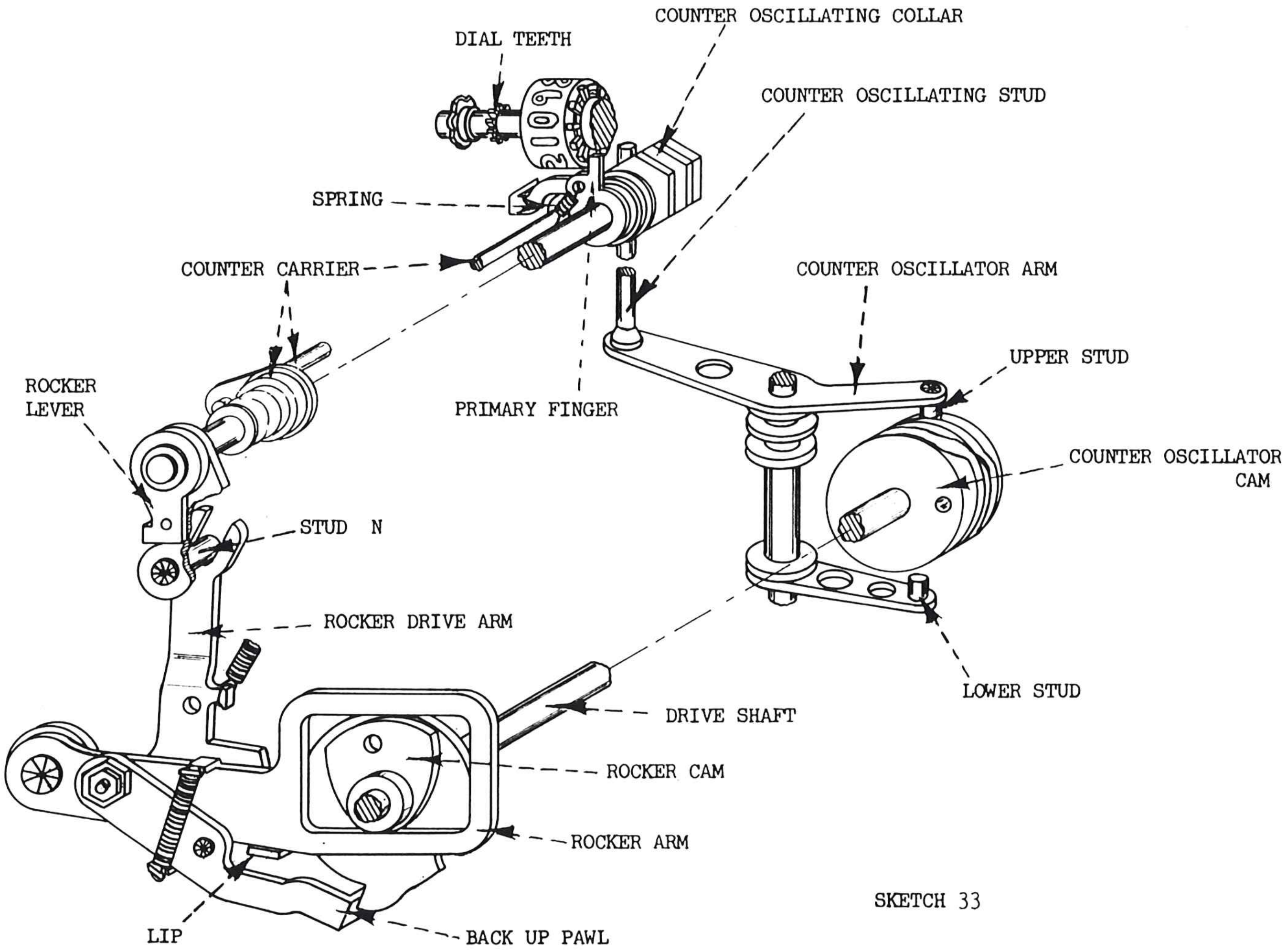
SKETCH 32

As mentioned before, the counter dials rotate one way in minus and the opposite in plus. Since we did not touch on the complete sequence of parts involved to turn the counter dials, you will trace the answers to these questions.

(a) Depress the plus key. Trace the sequence of parts that position the counter oscillator arm into the oscillator cam, Sketch 32.

(b) Depress the minus key and notice the upper stud engages the cam.

PARTS CAUSING COUNTER MOVEMENT:



SKETCH 33

(a) Have the plus key depressed and rotate the hand crank. Trace the sequence of parts and the action that will cause the primary finger to engage the dial, to turn the dial, to disengage from the dial and to return to home position, Sketch 33.

(b) Depress the minus key and cycle the drive shaft. Notice the difference in action of the parts to cause the counter dial to turn in the opposite direction.

(c) What is the purpose of the Back-Up pawl?

DIVISION:

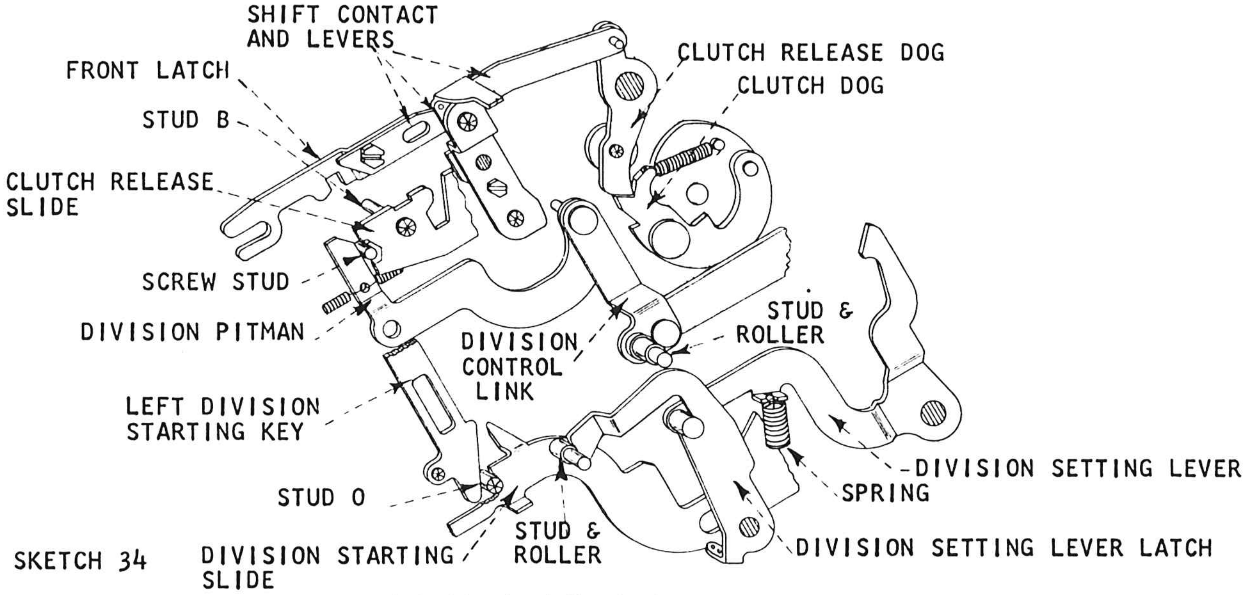
At this point of the course we will study the mechanical means of how the machine accomplishes division. The machine that you are studying is no doubt an STW which has the division aligner mechanism and since we do not want to study this feature at present, it will be passed over.

Division is basically done by subtraction. This can be demonstrated by dividing with the use of the subtract key, plus key, and the left shift key as such: Clear the carriage and shift the carriage to the 4th position, enter $625.00 in the keyboard (have add key up). Plus this figure into the upper dials. Manually clear the 1 from the lower dials and clear the keyboard. Place $25.00 in the keyboard. The 2 of the 25 will be under the 2 of the 625. Shift the carriage one position to the right for placing the 2 of the 25 under 6 of the 625. Now, pull the counter reverse key forward (to allow the counter to register positive on minus). Depress the minus key once, the 25 will be subtracted from the 62, leaving 375 in the upper dials and a 1 in the lower dials. Depress the minus key again; the 25 will be subtracted from the 37, leaving 125 in the upper dials and a 2 in the lower dials. Depress the minus key again; the 25 will be subtracted from the 12. Now, since the 25 is larger than the 12 the machine 'overdrafts' and the bell rings. The figure in the upper dials is 09999999999875 and the figure in the lower dials is 3. Because we have taken too much from the machine, as indicated by the 9's, it is necessary to restore or correct the dials to the 0's. This is done by depressing the plus key once. You again have 125 and 2. Now since the machine has overdrafted and restored it is necessary to shift the carriage to the left one space to align the keyboard 25 under 125 (a larger figure); depress the left shift key once. Now depress the minus key 5 times to subtract the 25 from the 125. At the completion of 5 depressions the upper dials read 0 and the lower dials read 25 -- the answer of 625 divided by 25. A sixth depression of the minus key will turn the upper dials to 9's or the overdraft. Depress the plus key to correct, depress the left shift key once, depress the minus again and another overdraft will occur because the upper dials read less than the amount in the keyboard. Continue to depress the plus key, left shift key and minus key until the carriage has reached first position. The last key depression is to be with the plus key to correct the upper and lower dials.

Now you have worked a division problem manually for purposes of demonstrating how the Friden Calculator accomplishes division. These same cycles occur during automatic division. Subtraction -- overdraft -- correction -- left shift.

You are to answer the following tracing operations.

CLUTCH RELEASING - DIVISION:



SKETCH 34

(Division aligner parts are not included in the following)

To delatch the division mechanism, for starting over on your tracing, rotate the hand crank so the carriage shifts two or more places to the right and push up on the division stop lever.

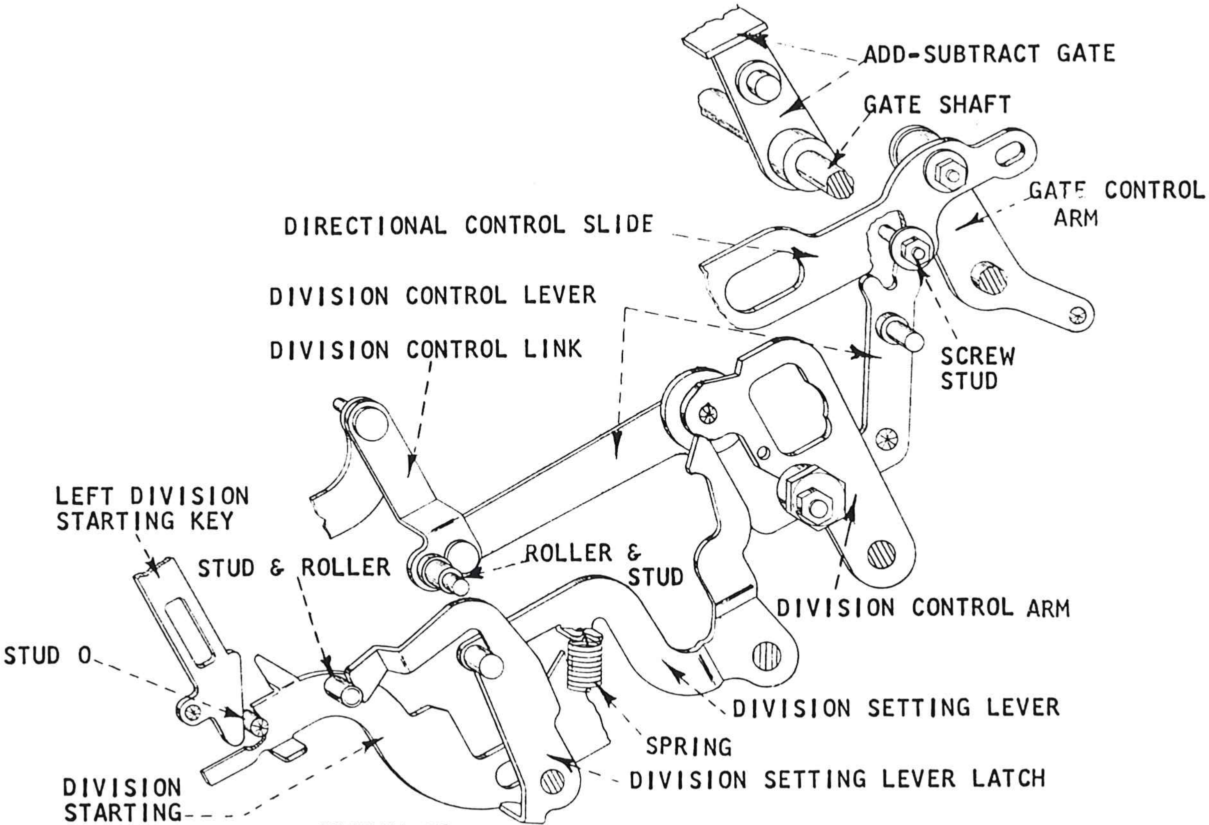
In the following tracing problems, wherever part of the answer is the same as a previous answer it is not necessary to rewrite the same operation. Just write in the difference in action.

(a) Depress the left (inside) division starting key. Trace the sequence of parts that move the clutch release dog from the clutch dog, Sketch 34.

(b) Observe how the division setting lever relatches as the drive shaft is cycled. The parts are not all illustrated.

(c) Observe how the keyboard clear link is disabled on the depression of the division keys. Refer to Sketch 34, and 28.

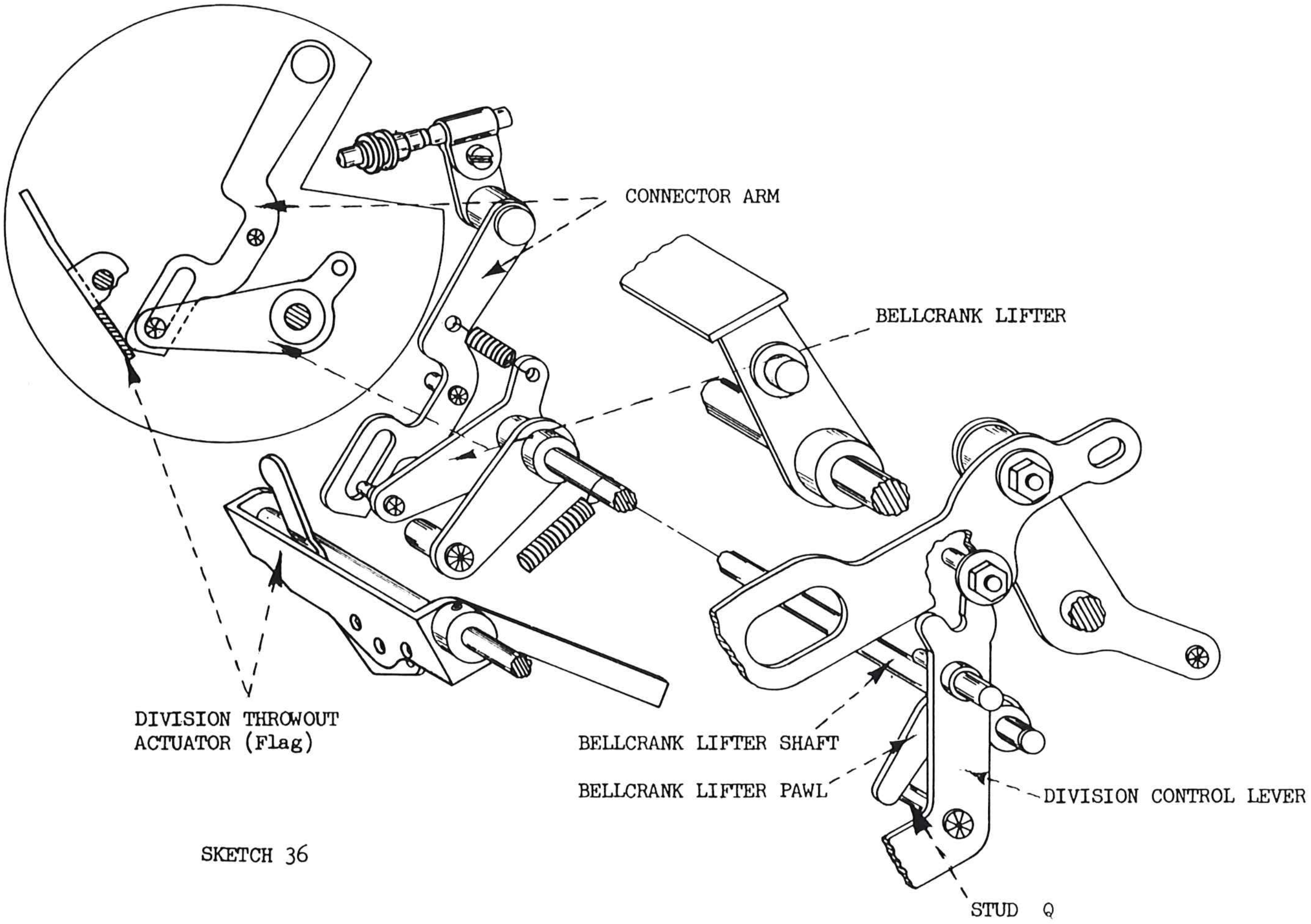
GATE POSITIONING - DIVISION:



SKETCH 35

Depress the division keys and trace the sequence of parts that place the add-subtract gate into the subtract position, Sketch 35.

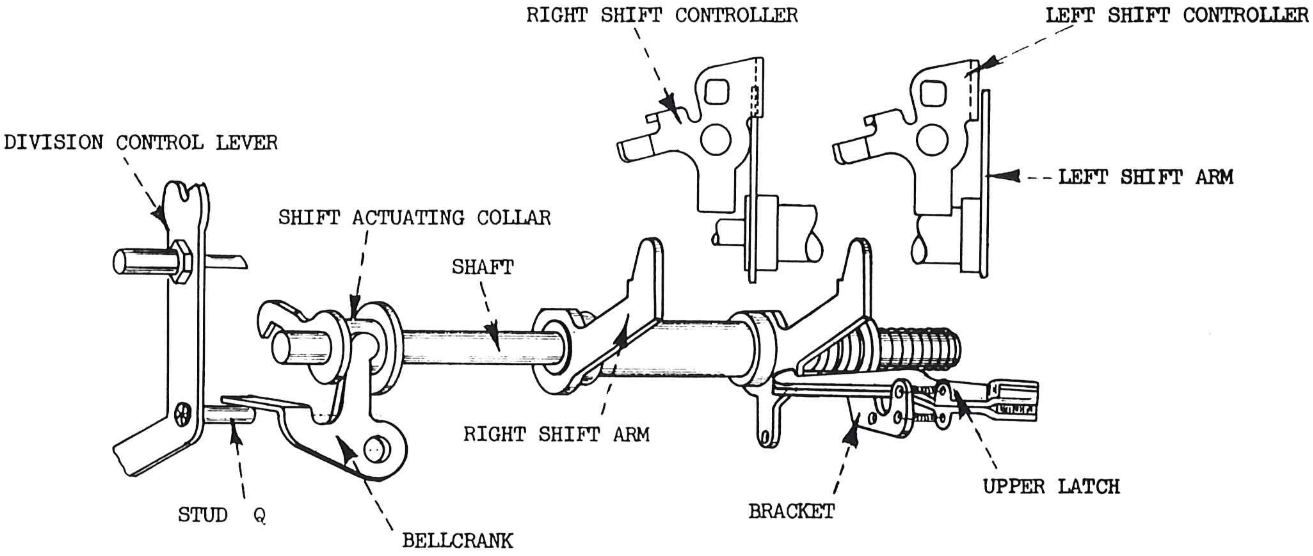
POSITIONING OF CONNECTOR ARM - DIVISION:



SKETCH 36

Trace the sequence of parts that swing the connector arm into position, Sketch 36.

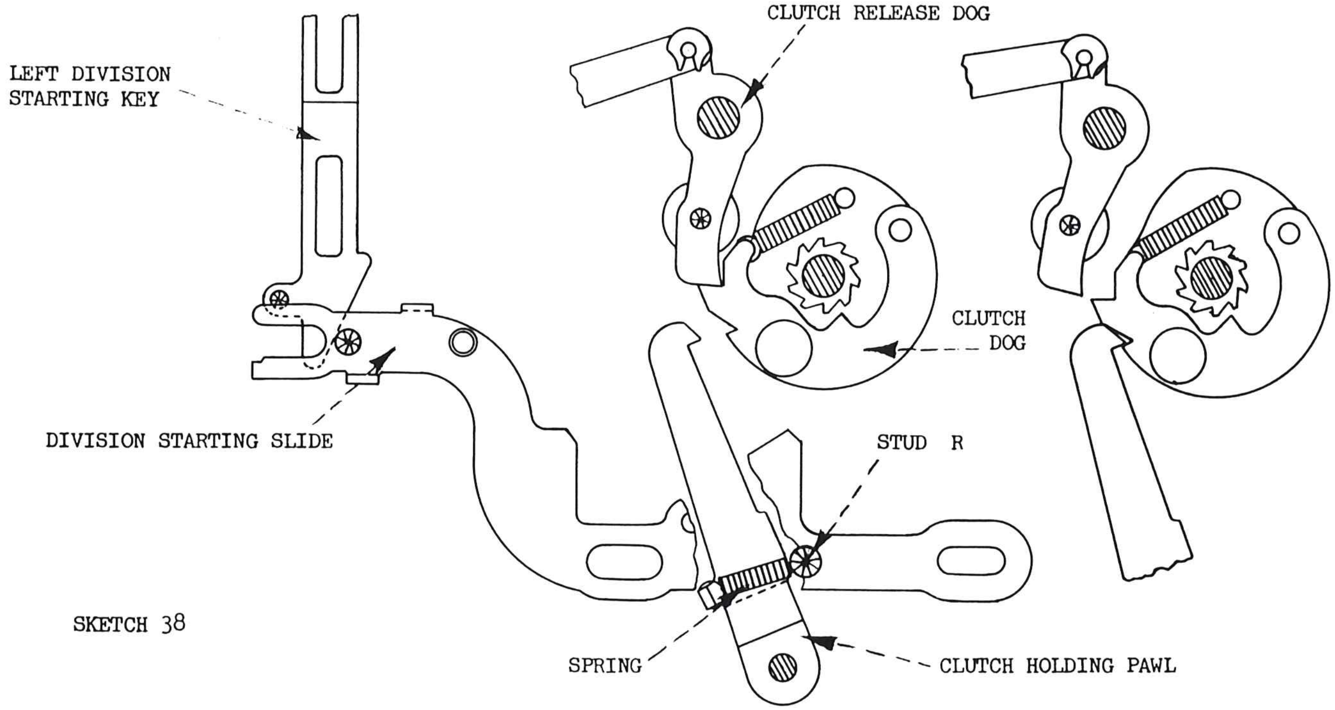
POSITIONING OF SHIFT ASSEMBLY - DIVISION:



SKETCH 37

Depress the left division key and trace the sequence of parts that actuate the shift actuating collar assembly into position (to the left). The assembly illustrated may vary slightly in design from the later style, but its function is the same, Sketch 37.

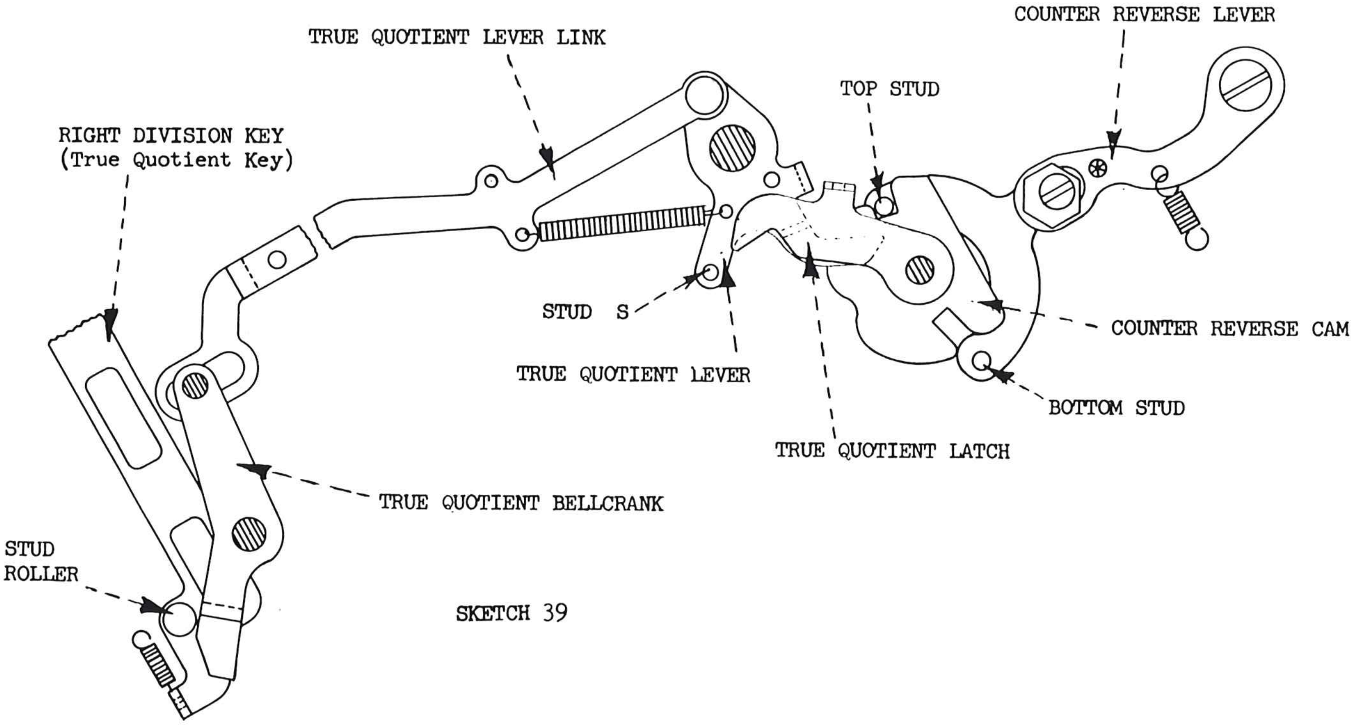
HOLDING OF CLUTCH DOG - DIVISION:



SKETCH 38

Plug in the extension cord. Depress the left division key and hold down. Notice that the clutch release dog has disengaged but the clutch dog does not engage the ratchet gear of the main drive gear. Trace how the clutch dog is held until the division key is released, Sketch 38.

POSITIONING OF COUNTER REVERSE LEVER - DIVISION:

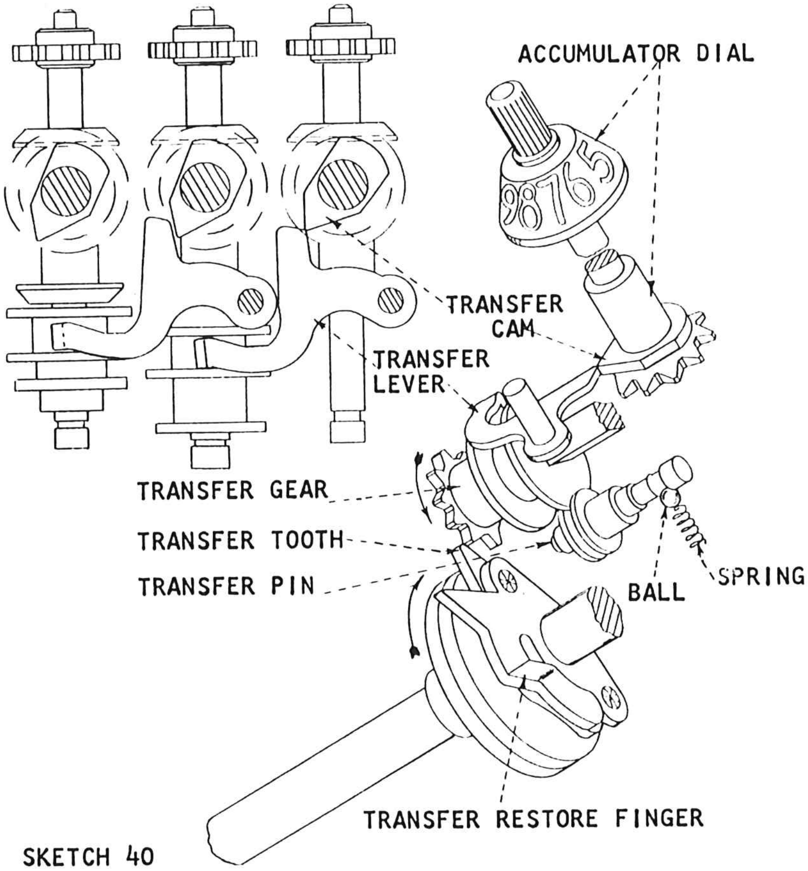


SKETCH 39

Whenever the left division key is depressed without depressing the right key, the counter dials will register negatively. When the right division key is depressed with the left key, the counter will register positively.

Since the first movement of the directional control slide and the add-subtract gate is the same as on the depression of the minus key, there must be some means of changing the direction of movement of the counter for a positive count during the subtract cycle in division. You'll recall that the counter will count negatively on the minus key because the upper stud of the oscillator arm is engaged in the oscillator cam and the count will be positive on the plus key because the lower stud of the oscillator arm is engaged. Now, in division, we don't want the upper stud engaged during the minus cycle nor the lower stud engaged during the add cycle; therefore, trace the sequence of parts that cause the oscillator arm to be positioned for a positive count on the minus cycle, Sketch 39. (Do not confuse the top and the bottom stud of the counter reverse lever with the upper and the lower stud of the oscillator arm)

OVERDRAFT - DIVISION:



SKETCH 40

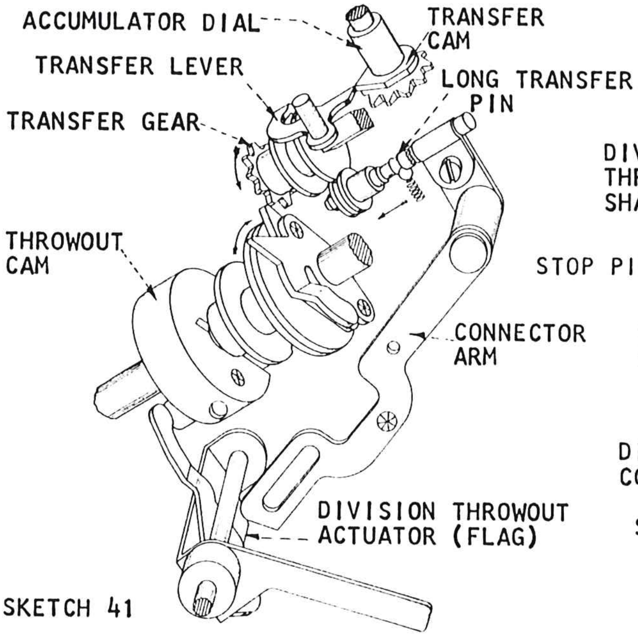
This is for the actual division operation only; therefore, please follow instructions to eliminate the division aligner operation.

Place the carriage in the 4th position -- dials clear. Place $625.00 in keyboard. Plus this in accumulator dials. Clear the "1" from counter dial. Clear the keyboard. Place $25.00 in the keyboard. Depress both division keys and release them. Rotate the hand crank. Now observe that the carriage shifts to the right automatically as the machine operates. This is the aligning operation. Continue to rotate the crank until the carriage reverses its direction and shifts one space back to the left. This places the "25" in the keyboard under the "62" in the upper dials. From this position the machine is in regular division and the answer to the following tracing operations starts from this position.

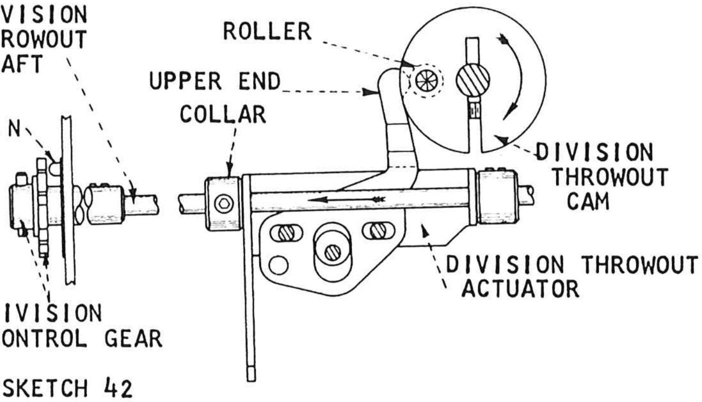
Observe as you continue to rotate the crank, the "625" is divided by "25". Observe the overdraft (that is, the dials turning to 9's). Observe that the "9's" are restored, observe that the carriage shifts, and then the "25" is subtracted from the "125" in the dials. (To start this operation again, start at the beginning per above instructions).

When does the overdraft occur and what is the mechanical action to make it occur? (Sketch 40)

CONNECTOR ARM ACTUATION - DIVISION:



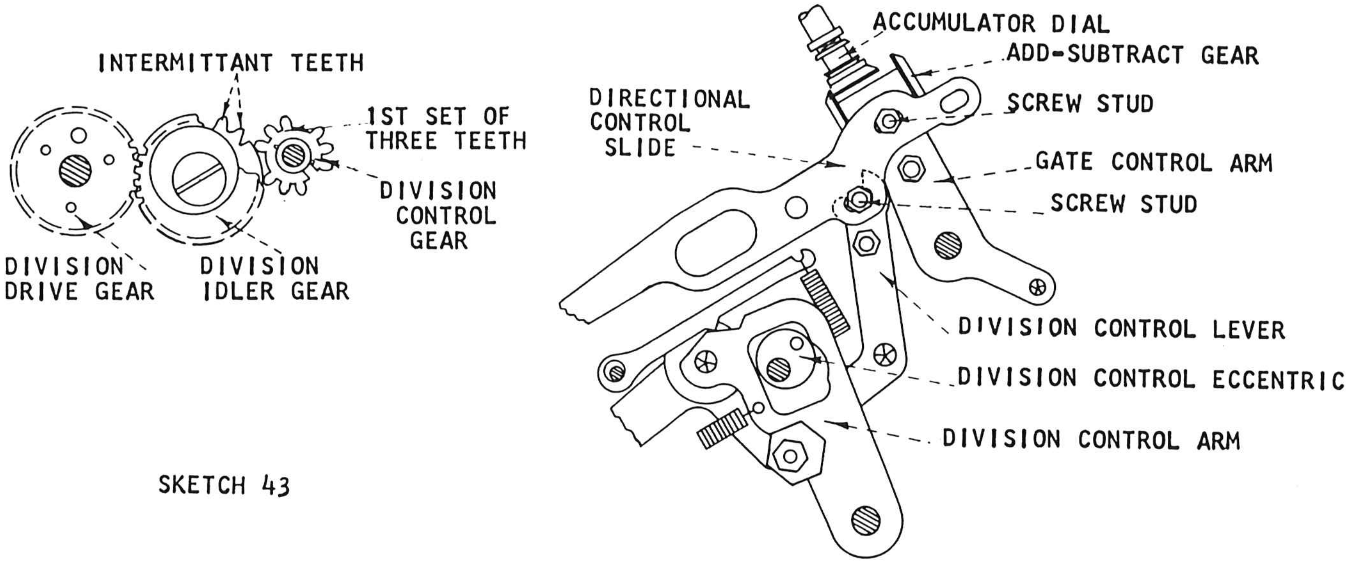
SKETCH 41



SKETCH 42

Trace the sequence of parts that cause the connector arm to actuate the flag on the overdraft, Sketch 41. After the flag has been actuated what causes the division control shaft to move to the right, Sketch 42.

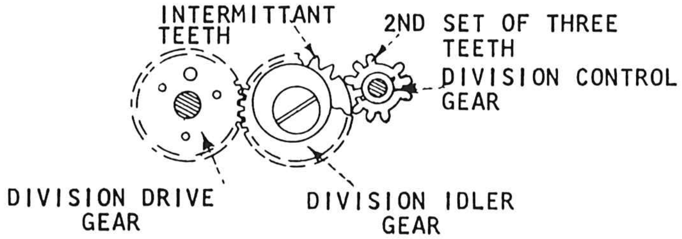
GATE MOVEMENT TO ADD - DIVISION:

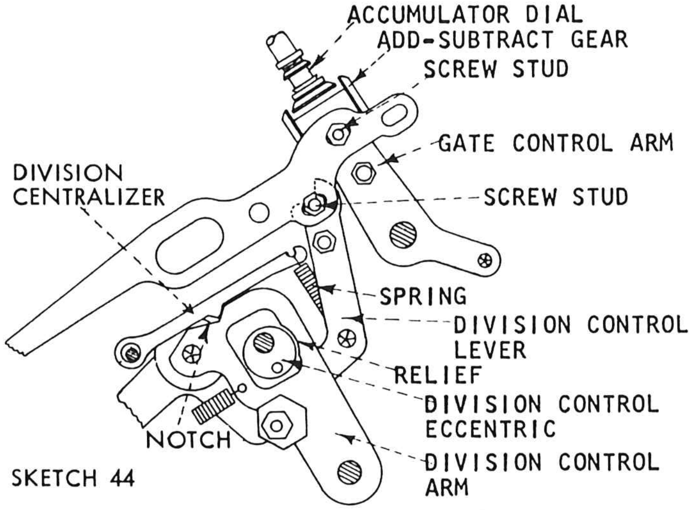


SKETCH 43

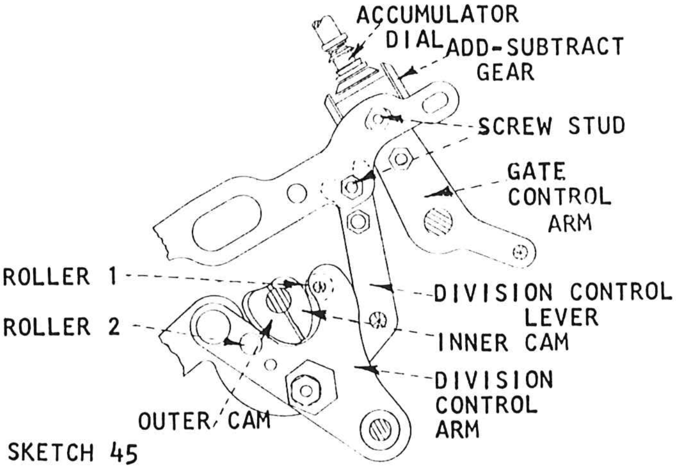
Trace the sequence of parts that are actuated to move the add-subtract gate from the subtract position to the add position for the restore cycle. Start with the rotation of the division idler gear, Sketch 43. (This is a continuation of the preceeding operation.)

GATE MOVEMENT TO NEUTRAL - DIVISION:





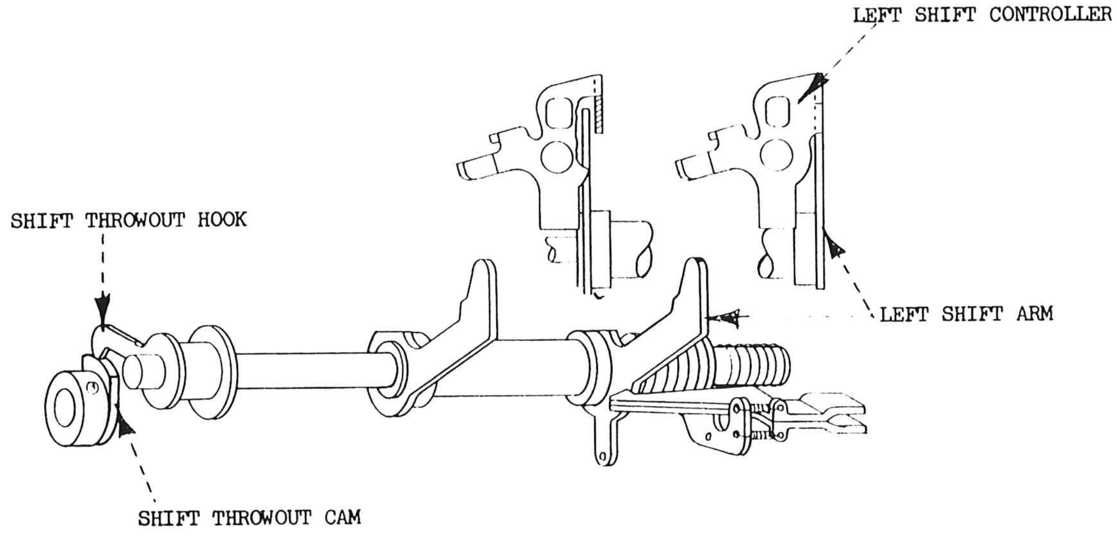
SKETCH 44



SKETCH 45

Trace the sequence of parts that cause and allow the add-subtract gate to centralize from the add position and how is it held centralized, Sketch 44 shows early style mechanism. Sketch 45 shows revised style mechanism. This is a continuation of the preceeding operations.

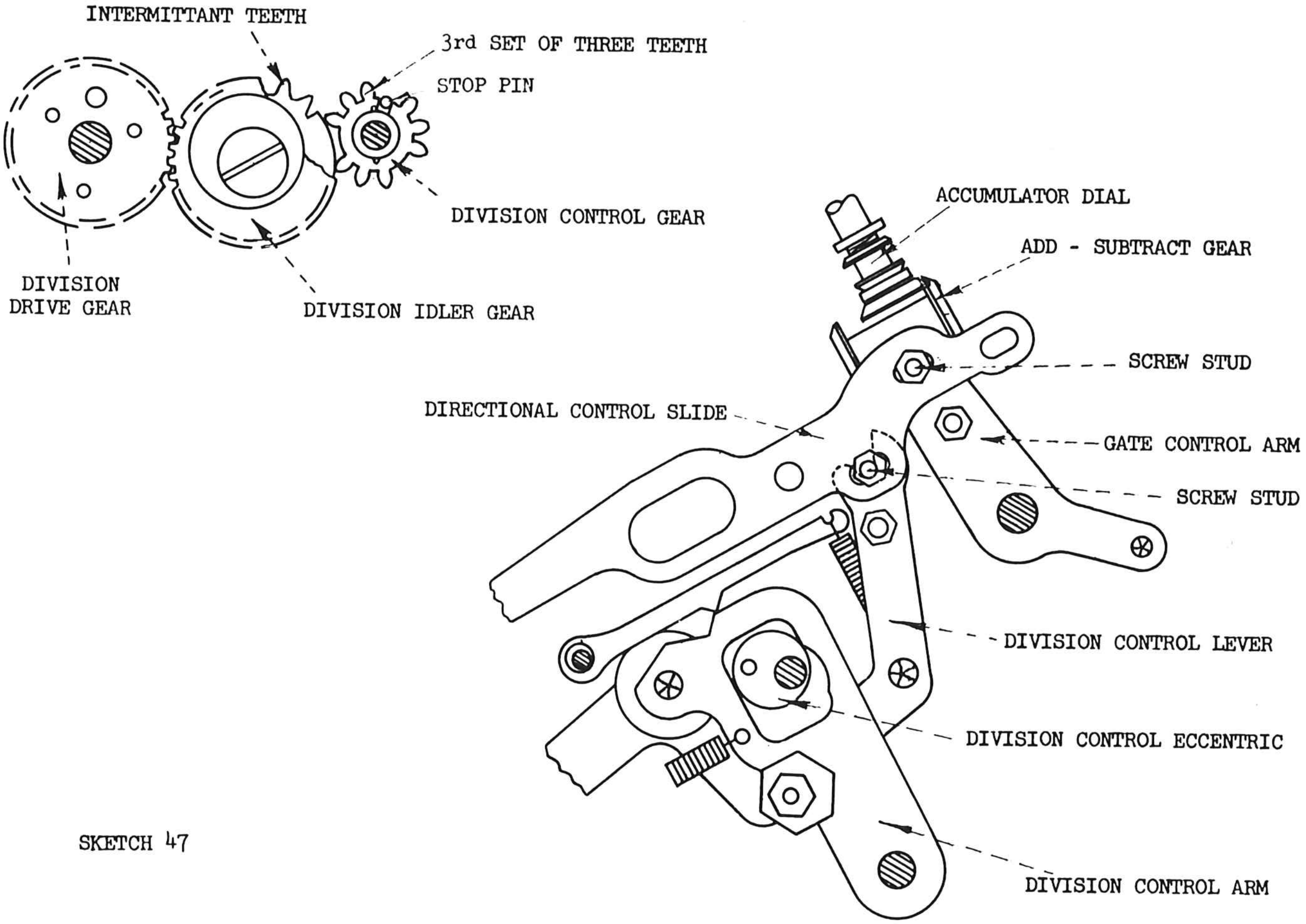
CARRIAGE SHIFT IN DIVISION:



SKETCH 46

When the add-subtract gate is in central position, the carriage shifts left. This is accomplished by the shift throwout cam actuating the shift throwout hook, Sketch 46. This action occurs as the second set of three teeth of the division control gear is actuated at the time of gate centralization. The actuation of the shift throwout hook causes the left shift arm to position the left shift controller to the rear. This causes the shift driver of the number 2 actuator to engage the shift disc to give the left carriage shift. (This is a continuation of the preceding operations).

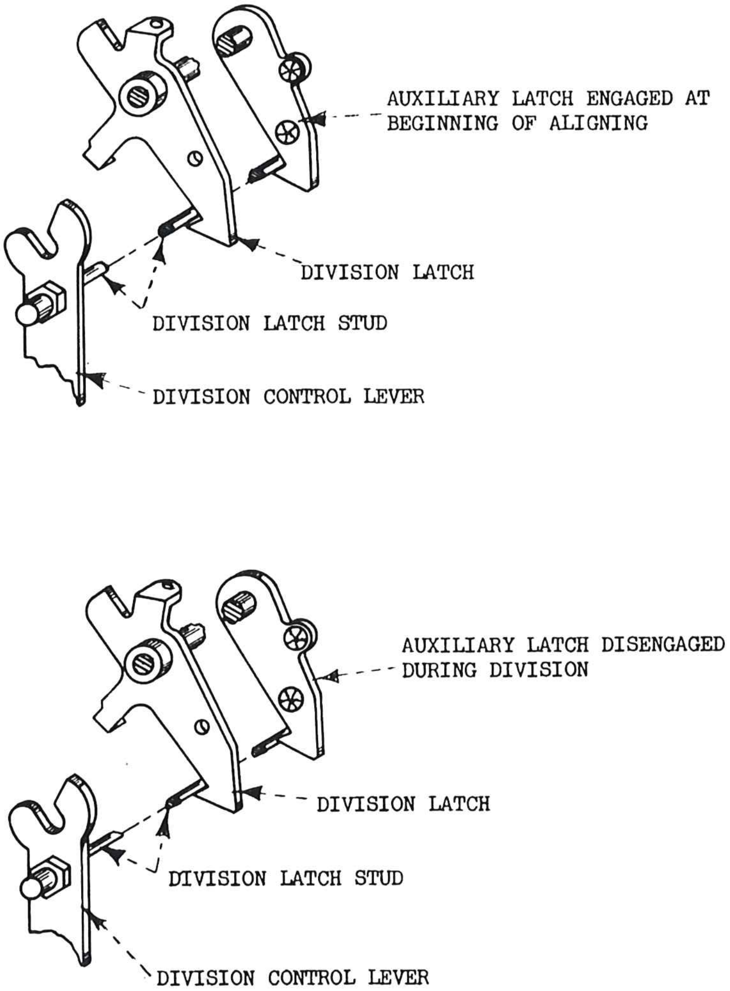
GATE MOVEMENT TO SUBTRACT - DIVISION:



SKETCH 47

Trace the sequence of parts that cause the add-subtract gate to move from the central position to the subtract position, Sketch 47. (This is a continuation of the preceding operations).

LATCHING OF DIVISION:



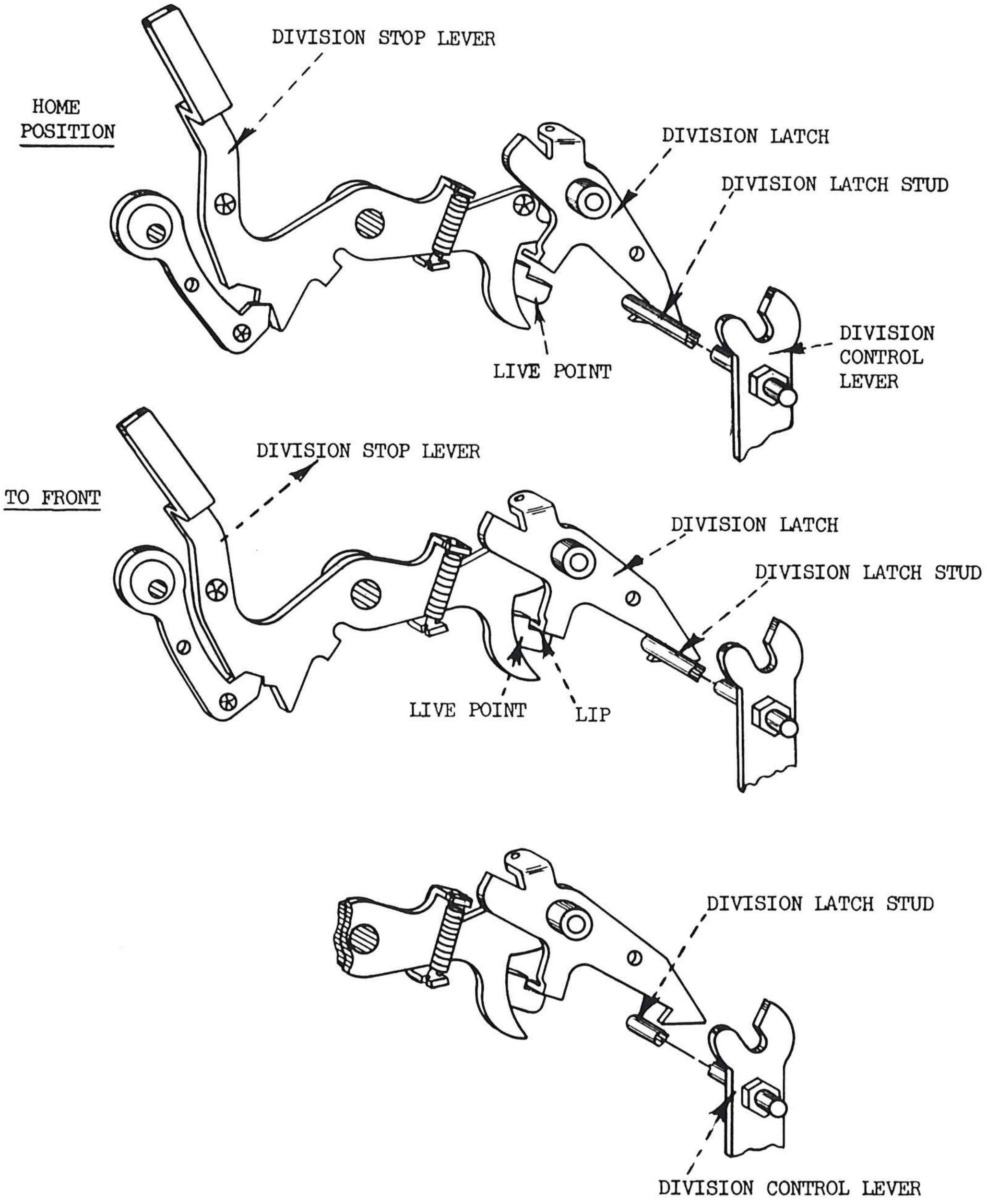
SKETCH 48

What part latches the division control levers and holds the machine in division? (Not division aligning operation) Sketch 48.

DELATCHING BY DIVISION STOP:

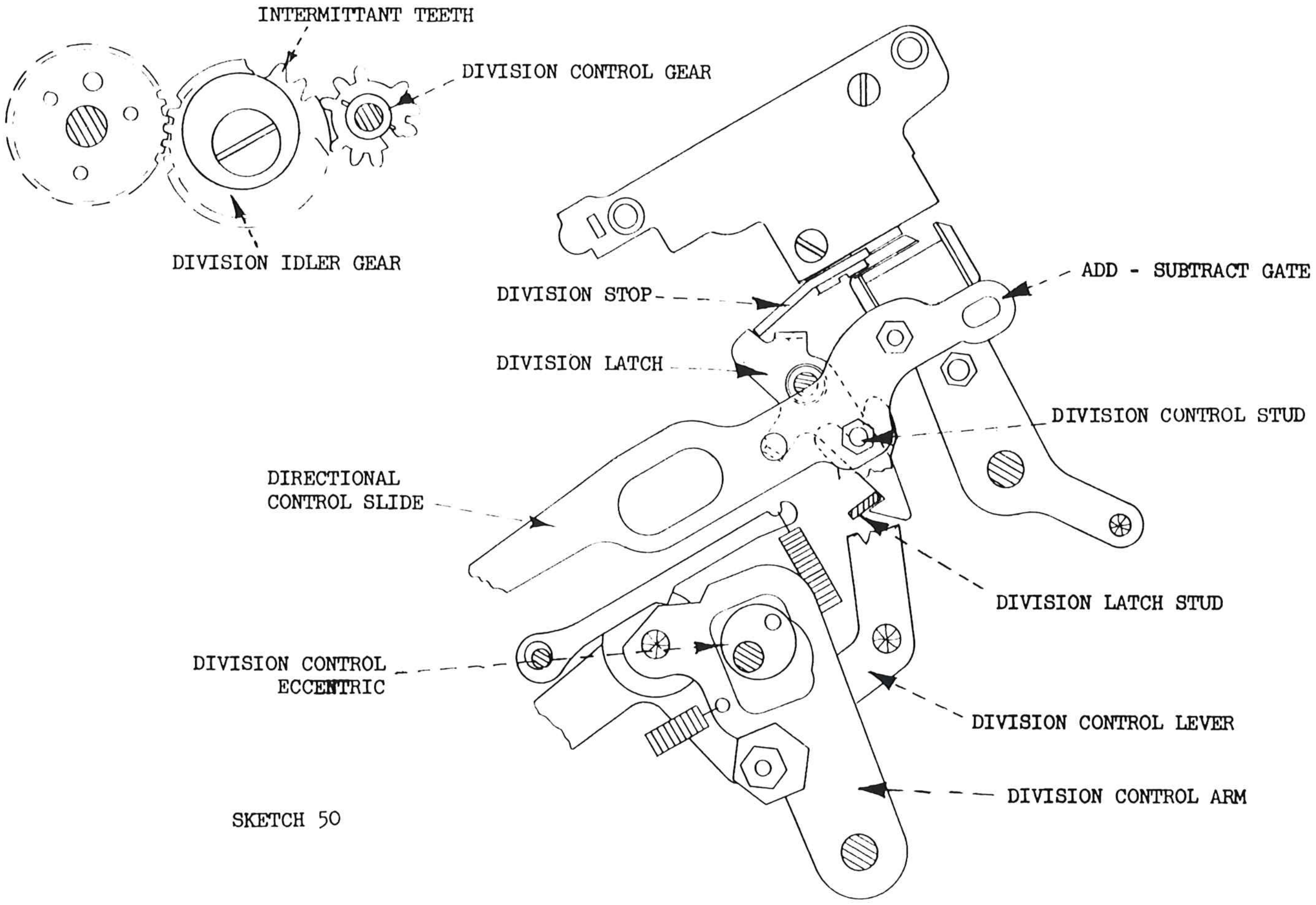
(a) When the machine is in division and the division stop lever is pulled to the front, the machine will stop. Trace the sequence of action that causes the division control lever to be delatched, Sketch 49. (The motion and the position of the division control lever is important for your answer).

(b) How is the division control lever delatched when the division stop lever is pushed to the rear? Sketch 49.


HOME POSITION
DIVISION STOP LEVER
DIVISION LATCH
DIVISION LATCH STUD
LIVE POINT
DIVISION CONTROL LEVER
TO FRONT
DIVISION STOP LEVER
DIVISION LATCH
DIVISION LATCH STUD
LIVE POINT
LIP
DIVISION LATCH STUD
DIVISION CONTROL LEVER

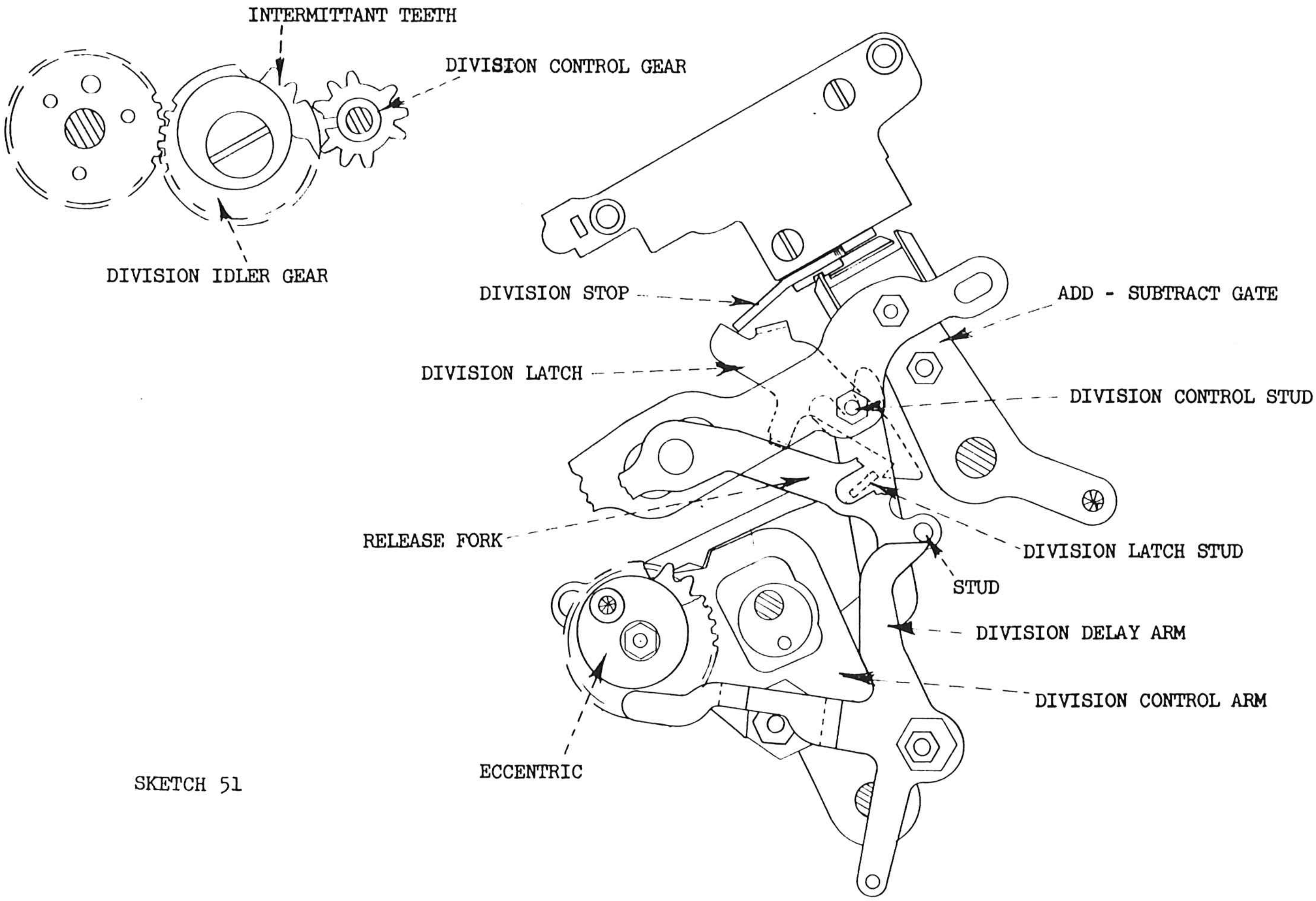
SKETCH 49

DELATCHING IN CARRIAGE FIRST POSITION:



SKETCH 50

What is the sequence of action and the parts involved that delatch the division control lever when the carriage reaches first position? (The motion and position of the division control lever is important in your answer). Refer to Sketches 50 and 51.


INTERMITTANT TEETH
DIVISION CONTROL GEAR
DIVISION IDLER GEAR
DIVISION STOP
ADD - SUBTRACT GATE
DIVISION LATCH
DIVISION CONTROL STUD
RELEASE FORK
DIVISION LATCH STUD
STUD
DIVISION DELAY ARM
DIVISION CONTROL ARM
ECCENTRIC

SKETCH 51

DIVISION ALIGNER:

The following explanation will be on the features which compose the division aligner mechanism. The regular division operation after alignment is the operation which you have traced and is the same in all models. Division alignment is a feature for positioning the carriage to the right automatically to align the figures in the accumulator dials with the figures in the main keyboard. The depression of the division keys pre-sets the parts for division as well as the division aligner parts.

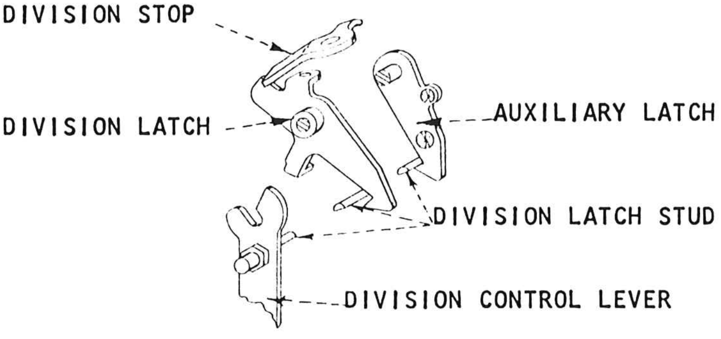
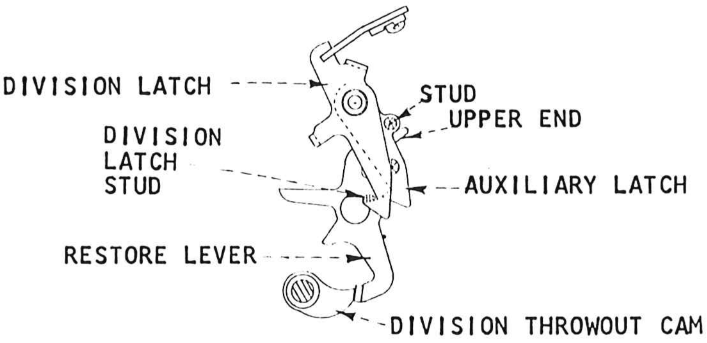


FIG. 1



SKETCH 52 FIG. 2

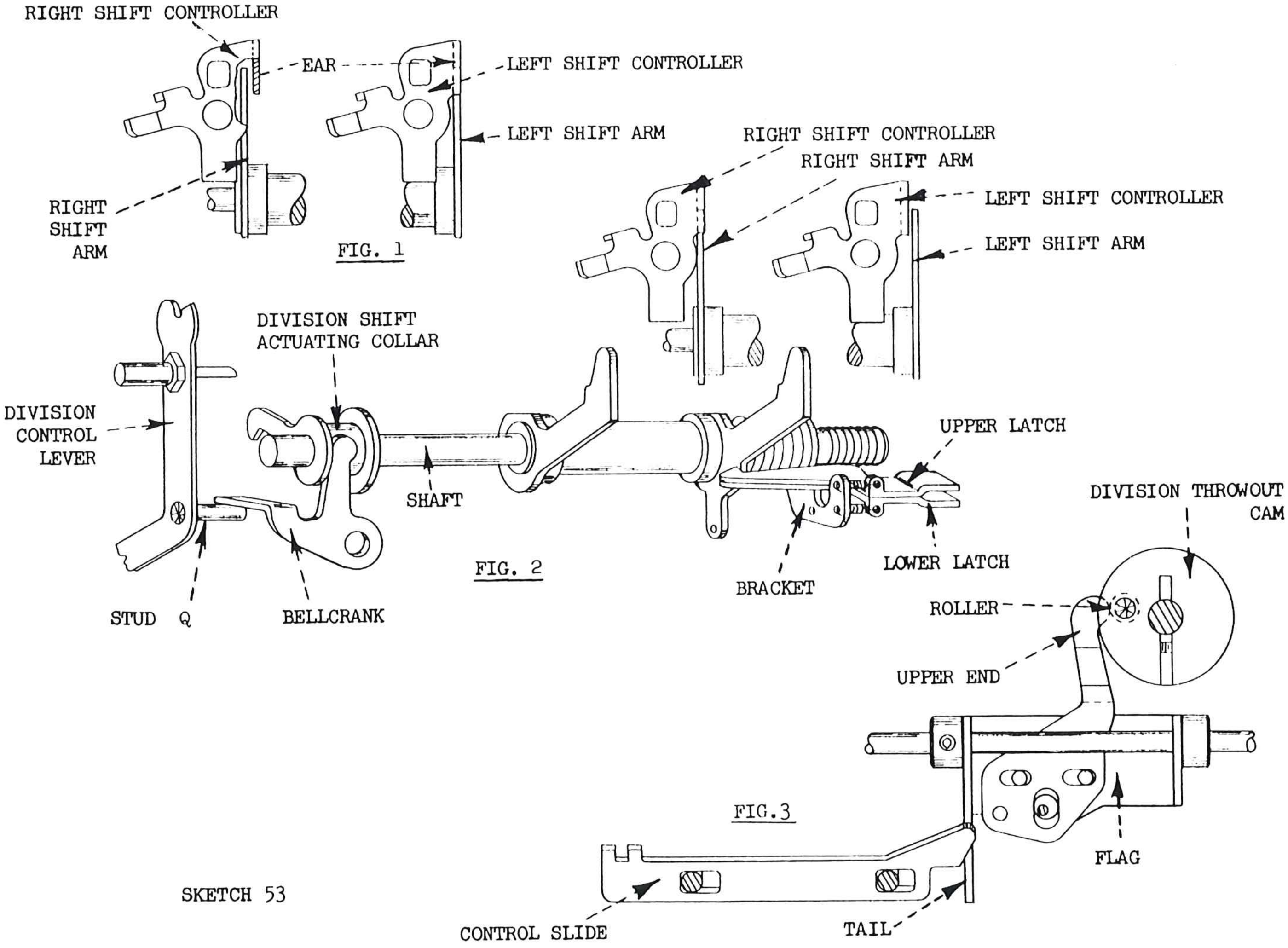
AUXILIARY LATCH:

On the STW the division control unit can be latched with the carriage in the first position and with the division stop on the carriage engaged with the division latch. This latching action of the division control lever is not possible on machines that do not have the division alignment mechanism.

The division control lever is latched by the auxiliary latch which is located adjacent to the division latch, Sketch 52. It is approximately .018 shorter than the division latch. When the division control lever is actuated on the depression of the division keys, the division latch stud latches onto the auxiliary latch first and will remain there until the division control gear assembly has revolved to the third set of teeth on the division control gear. The action is as follows: Have the carriage in first position and the division stop on the carriage engaged with the division latch. Depress the division keys and observe that the division latch stud latches onto the auxiliary latch, Fig. 1. Cycle the hand crank. When the 1st set of three teeth of the division control gear is picked up, the add-subtract gate moves to the add position. When the 2nd set of three teeth is picked up, the gate moves to the shift position and the continued cycling of the hand crank causes the carriage to shift to the right. The division stop on the carriage moves off the division latch and the division latch then engages the division latch stud. When the 3rd set of three teeth is picked up, the gate is moved to the subtract position. As the gate is moving down, the auxiliary latch is disengaged from the division latch stud, Fig. 2. This disengagement is caused by the division throwout cam contacting the restore lever. The upper rear end of the restore lever contacts the stud on the auxiliary latch and moves the latch rearward from under the division latch stud. When this occurs the division control lever drops slightly and the division latch stud rests on the division latch. The division latch will remain latched until the completion of a division problem or until delatched by the division stop lever.

No matter where the carriage is located at the time the division keys are depressed, the division latch stud always latches onto the auxiliary latch first. The only purpose of the auxiliary latch is to allow the division control unit to latch when the carriage is in first position with the division stop engaged with the division latch.

POSITIONS AND OPERATIONS OF DIVISION ALIGNER PARTS:



SKETCH 53

Place a 1 in the first keyboard column; have the accumulator dials clear; have the carriage in the first position. Looking at the machine from the rear the division shift actuator will be in home position (to the right) with:

The right shift arm to the right of the ear on the right shift controller, Fig. 1, Sketch 53.

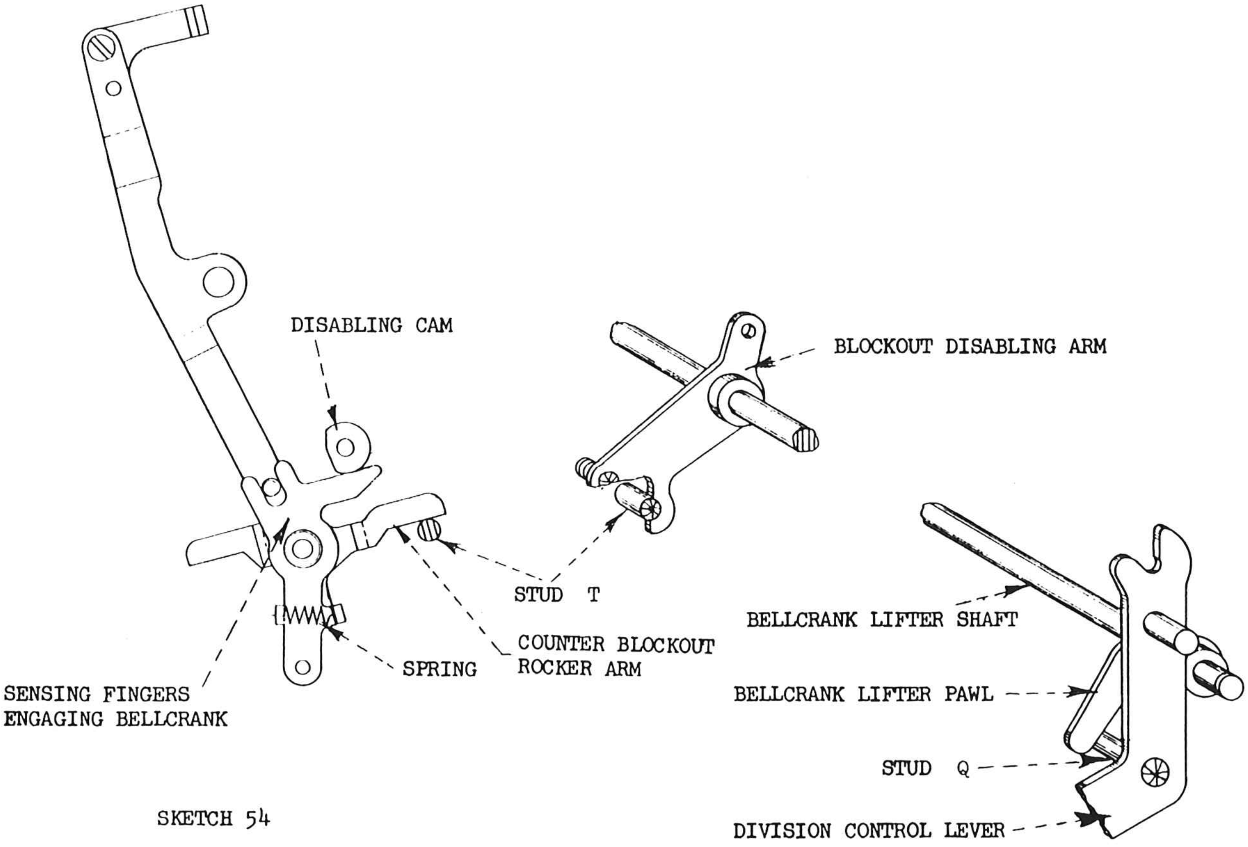
The left shift arm having a full bite to the ear of the left shift controller, Fig. 1, Sketch 53.

When the division keys are depressed, stud Q on the division control lever actuates the bellcrank. The upper end of the bellcrank fits into the shift actuating collar and actuates the shaft which has on the left end the bracket for securing two latches: The division latch (upper latch) and the sensing latch (lower latch).

The two latches are latched over the left shift arm but the lower latch being shorter is in contact with the left shift arm and pulls the assembly to the left which positions the right and the left shift arms to the left. The right shift arm will be in alignment with the ear of the right shift clutch controller, and the left shift arm will clear to the left of the ear of the left shift controller, Fig. 2.

Attached to the bottom of the left shift arm is the control slide for the flag, Fig. 3. When the left shift arm is actuated to the left, the control slide moves to the left and cams the tail of the flag to position the upper end so the roller on the division throwout cam of the #6 actuator will be contacted. This contacting of the two parts will actuate the division control shaft and position the division control gear into mesh with the division idler gear when the drive shaft is rotated.

POSITIONS AND OPERATIONS OF THE DIVISION ALIGNER PARTS: (cont'd)



SKETCH 54

Also when stud Q on the division control lever is raised, it actuates the bellcrank lifter pawl on the right end of the bellcrank lifter shaft, Sketch 54. This action rotates the shaft so the blockout disabling arm located at the left end of the shaft is moved inward allowing stud T on it to contact and actuate the blockout arm. This stretches the spring and adds tension to the sensing fingers engaging bellcrank assembly. The sensing fingers engaging assembly cannot move because the rear end is contacting the round side of the disabling cam.

POSITIONS AND OPERATIONS OF THE DIVISION ALIGNER PARTS: (cont'd)

The preceding explanation covered the presetting of the aligner parts. Now, with the parts preset and still observing from the rear, rotate the drive shaft.

The division setting levers will be restored and the mechanism will be held in the latched position by the division latch. As the drive shaft is rotated, the "1" set in the first column will cause a transfer action to occur across the carriage. When the transfer action overdraft reaches the position of the long transfer pin, the connector arm will be actuated which in turn will move the inside bail and cause the upper latch to move away from the left shift arm. When the long transfer pin restores, so will the connector arm, the inside bail, and the upper latch. This same action will again occur when the restore transfer action occurs.

The action of the upper latch off and on the left shift arm is due to the lower latch being .018 shorter. As long as the lower latch is latched, the upper latch will delatch and relatch onto the left shift arm. The difference in length allows the shift engaging levers to move to the right slightly and stop against the upper latch when the lower latch is delatched.

Continue to rotate the drive shaft and as the carriage shifts to the right, the dummy sensing finger moves from under the detecting lever, Sketch 55. This allows the detecting lever to move rearward because there are no figures in the upper dials and because the disabling cam rotated its flat side towards the sensing fingers engaging bellcrank. This latter action occured as the carriage started to shift.

When the detecting lever moves rearward, the control link actuates the outside bail thus causing the lower latch to delatch from the left shift arm. When this action occurs, the shift actuator assembly moves slightly to the right and is stopped by the upper latch.

When the shift engaging levers are against the upper latch, the shift arms are located as follows in the shift position:

The left shift arm clears the ear of the left shift controller approximately .005 - .010.

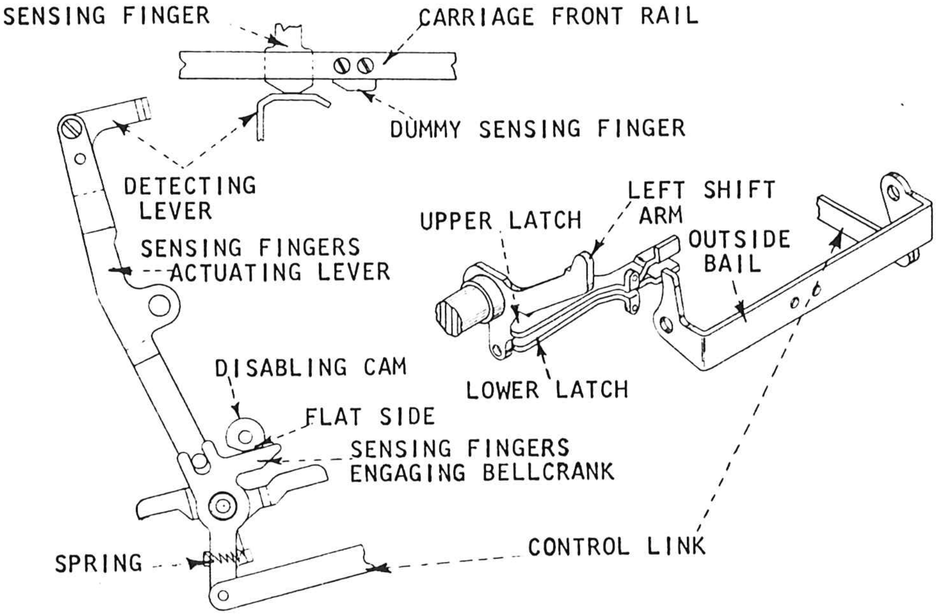
The right shift arm has approximately 50% minimum bite to the right of the ear on the right shift controller.

On the next overdraft the upper latch will be delatched from the left shift arm and the shift levers will move to the right and align the shift arms as follows for the shift operation in regular division:

The left shift arm will have 100% bite on the left shift controller ear.

The right shift arm clears to the right of the ear on the right shift controller. (The shift engaging levers will be in home position again).

When both the upper and lower latches are delatched from the shift engaging lever, the machine will have completed the aligning operation and will then go into the regular division operation.



SKETCH 55

POSITIONS AND OPERATIONS OF DIVISION ALIGNER PARTS: (cont'd)

So far the action of the division aligner has been observed with the accumulator dials clear. This action has illustrated the positions of the division shift actuator and the action of the upper and lower latches.

Place a 1 in the first keyboard column. Have the carriage in first position. Place a 4 in the fourth accumulator dial. Now, looking from the rear of the machine press the division keys and operate the machine with the hand crank.

The first revolution will cause an overdraft or transfer in the accumulator dials, but notice this action does not continue past the accumulator dial having the figure 4. On the next revolution of the machine notice the add-subtract gate moves from the subtract position to the add or restore position. This is caused by the division control gear being moved out and into mesh with the division idler gear. The action of the division control gear coming out was accomplished by the control slide, Sketch 53, Fig. 3 camming the upper end of the flag into contact with the roller on the throwout cam.

Notice the upper latch did not delatch from the left shift arm on the first revolution because there was no transferring past the accumulator dial having the 4.

Notice when the shift cycle is made, the detecting lever will move in and allow the lower latch to delatch from the left shift arm. This action is the same as mentioned before.

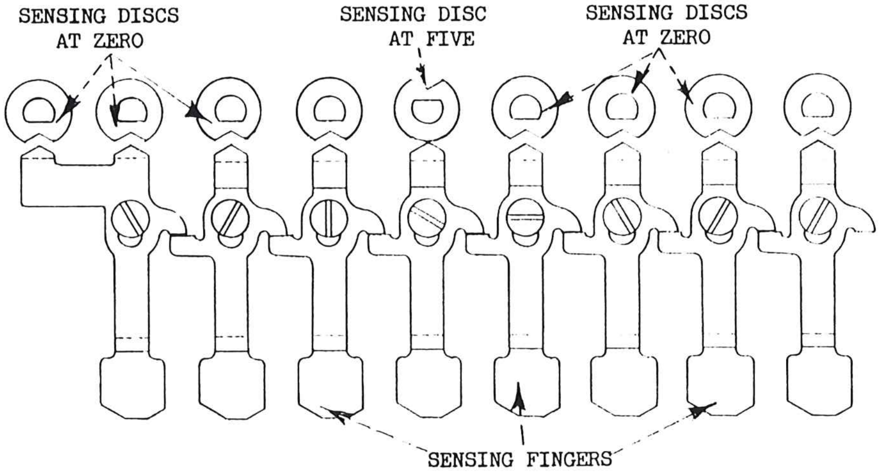
When the lower latch delatches, the shift engaging levers will move to the right and stop because of the upper latch contacting the left shift arm.

The next cycle with the add-subtract gate in the subtract position will again cause a transfer to the figure in the accumulator dial but not past this dial, and the continuing cycles will give the restore cycle - the right shift cycle - and the overdraft cycle. This will continue until the carriage has shifted to align itself so the figure 4 in the 4th accumulator dial will be to the right of the 1 in the keyboard.

When the add-subtract gate moves into the subtract position after the last right shift cycle (which placed the 4 in the accumulator dial to the right of the 1 in the keyboard) and the overdraft occurred, there is a transfer or overdraft in the accumulator dials to the position of the long transfer pin. This actuates the pin thus actuating the connector arm. The stud on the left side of the connector arm will actuate the inside bail to delatch the upper latch from the left shift arm. After the upper latch is delatched, the machine goes into the regular division operation.

The preceding explanation illustrated that the upper latch holds the shift engaging levers for a right shift, in case the lower latch has been delatched because of the figures in the accumulator dials. The upper latch holds until the carriage has aligned the figures in the accumulator dials with the figures in the keyboard.

SENSING FINGERS - DIVISION ALIGNER:



SKETCH 56

On the left half of the carriage you will notice there are several levers in front of the dials. These are the sensing fingers. They determine the time that the lower latch will delatch.

Notice under the numeral part of the dial there is a cam with a V-shaped notch. When there is a zero in the dial, this notch faces the front and is in line with the sensing finger, thereby allowing the sensing finger to move into the notch. If there is a figure in the dial, the V-notch will not be aligned with the sensing finger, and the sensing fingers cannot move to the rear.

Place a figure in one of the center dials in line with the sensing fingers. (The dials to the left and the right of this dial are to have O in them). Try and push any of the sensing fingers to the right of the figured dial, to the rear. Even though there are O's in these dials, the sensing fingers will not go to the rear because the sensing fingers interlock each other. Try the sensing fingers to the left of this dial. They will go rearward.

Whenever there is a figure in a dial, the sensing finger in line with this dial will interlock all to the right, and not affect those to the left.

PREVENTING THE LOWER LATCH FROM DELATCHING WHEN DIALS HAVE FIGURES:

Have the carriage in first position; place a 1 in the 7th keyboard column and place a 5 in the 16th accumulator dial. Depress the division keys and rotate the drive shaft by hand crank.

Looking at the machine from the rear, notice that all the levers and parts position the same as before.

Rotate the hand crank and notice that the first revolution in the subtract position will give an overdraft to the long transfer pin, which will actuate the connector arm, the inside bail, and the upper latch. Continue to rotate the hand crank and notice as the carriage shifts from the first to the second position that the lower latch does not delatch from the shift engaging levers.

Notice that the flat side of the disabling cam is next to the sensing fingers engaging bellcrank but that the bellcrank is not actuated. The reason for this is that the sensing finger is blocking the detecting lever from moving to the rear, thus not allowing the bellcrank to actuate. The actuation of the bellcrank would actuate the control link, the outside bail, and the lower latch.

Continue to rotate the hand crank and notice the action of the upper latch and the action of the lower latch. The carriage will continue to shift to the right until the figure in the 16th accumulator dial is aligned with the last column of the keyboard, at which time the lower latch will be delatched from the left shift arm. When the lower latch is delatched, the upper latch will hold the shift actuating levers in place for a right shift until the figure in the accumulator dial is past the figure in the keyboard column. After this occurs in the next subtract cycle will give an overdraft to actuate the long transfer pin, the connector arm, the inside bail, and the upper latch. When this happens the shift actuating levers will restore to the right and the machine will go into a regular division operation. The preceding illustrates the purpose of the sensing finger and the action of the upper and lower latches when there are figures in the accumulator dials.

DELATCHING THE UPPER AND LOWER LATCHES IN THE LAST CARRIAGE POSITION:

Have the carriage in first position, place a 1 in the last keyboard column and place a 5 in the last accumulator dial. Depress the division keys and rotate the drive shaft by hand crank.

Looking at the rear of the machine, observe the action of the parts and of the latches as the carriage aligns to the right. Observe as the carriage shifts into the last carriage position (shifts to the extreme right). The detecting lever moves inward for the reason of the short sensing finger. This action causes the delatching of the lower latch. (Later models do not have the short sensing finger. The detecting lever just moves off the last sensing finger which is double pointed at the dial end).

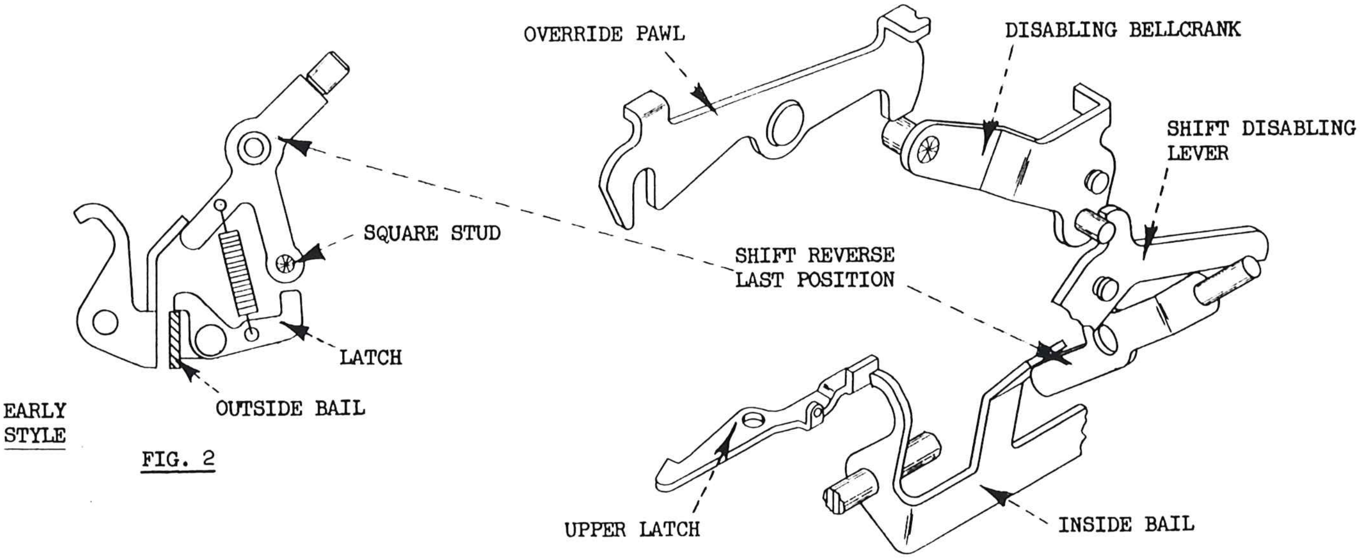


FIG. 2

FIG. 1

SKETCH 57

Fig. 1, Sketch 57. The last right shift cycle with the carriage in the last position will actuate the override pawl, which actuates the disabling bellcrank and the shift disabling lever. This lever actuates the shift reverse - last position assembly to contact the extended lip in the center of the inside bail. This action causes the delatching of the upper latch.

On early models, the rear arm of the shift reverse last position assembly has a square stud, Fig. 2, Sketch 57, that is latched by the latch on the outside. This is to keep the upper latch delatched until the right shift cycle is completed. When the disabling cam rotates so the round side actuates the sensing fingers engaging bellcrank, the outside bail is actuated to delatch from the square stud of the shift reverse assembly.

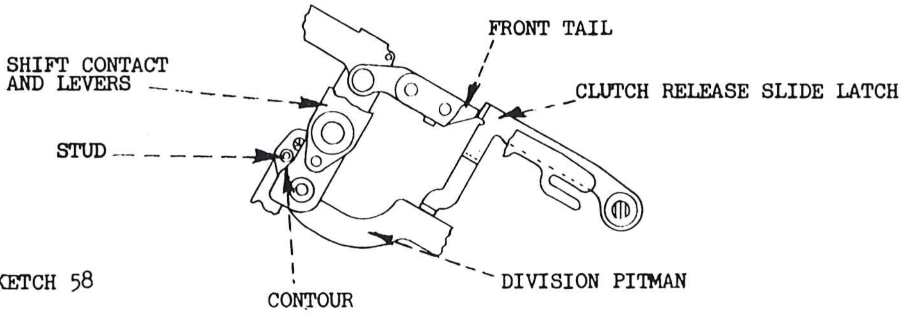
The add-subtract gate goes into the subtract position and will allow the figure in the keyboard to be subtracted from the figure in the accumulator dials until the overdraft can be accomplished. Then the machine will start to divide normally with the carriage shifting to the left.

The above shows how the two latches are delatched when the carriage reaches the last position.

There are a couple of other actions that take place on the STW that do not take place on machines not haveing division aligner.

CLUTCH RELEASE SLIDE LATCH:

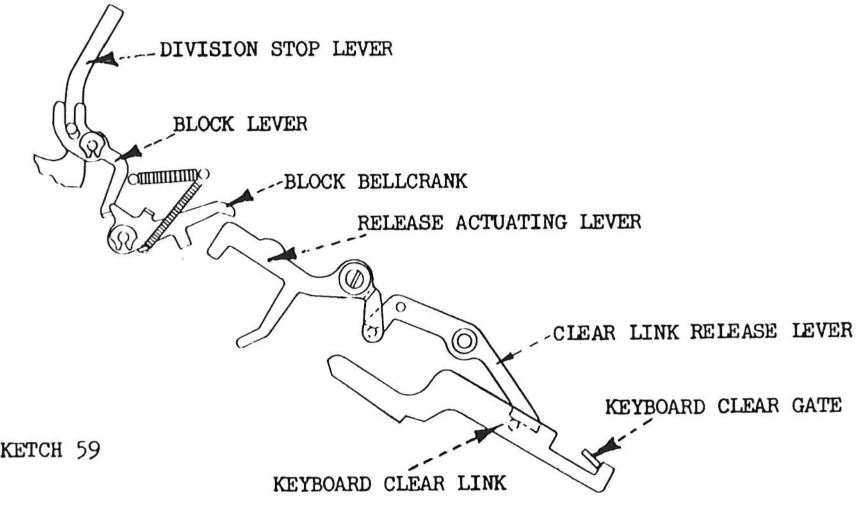
With the add key down, depress the division keys and rotate the drive shaft by hand. Observe that the first revolution will cause the front tail of the shift contact and lever assembly to raise. Observe the extended lip of the clutch release slide latch contacts and latches the tail. This is to keep the clutch released during division with the add keys down. On most W models an additional means of holding the clutch released is in the addition of a contour to the bottom of the "crows" foot. This contour is contacted by a stud on the division pitman. Should the clutch latch fail, this part will take over and keep the clutch open.



SKETCH 58

KEYBOARD NON CLEARANCE:

With the add key down and figures in the keyboard, depress the division key. Rotate the drive shaft by hand until the carriage is shifting to the left in normal division. Pull down on the division stop lever and notice that the keyboard does not clear when the machine restores to normal. Trace from the division stop lever the reason why the keyboard does not clear.



SKETCH 59

MULTIPLICATION:

We will now trace the mechanical operation of the multiplier section. This section consists of a group of parts that when placed into action will result in the automatic operation of the basic machine.

Multiplication is a series of additions and carriage shifts, and you can demonstrate this by operating the calculator as follows:

Place $625.00 in the main keyboard. Have the dials clear, the carriage in first position, and the add key up. Multiply the $625.00 by 25. Depress the plus key 5 times. The first counter dial will register 5, the upper dials will register $3125.00. You have added $625.00 (5) times. Next shift the carriage one position to the right with the right shift key. Now depress the plus key 2 times. The counter dials will register 25, the upper dials register $15625.00. You have added the $625.00 twice to the figure obtained from adding 5 times. You can also do the problem in this manner: Use the same set up but hold down the plus key 25 times. In this operation the machine took 25 cycles to multiply. The first method took 8 cycles, that is, 5 add cycles - 1 shift cycle - 2 add cycles.

This manual operation is accomplished automatically by the use of the multiplier section. This is what we will take you through. We have written the mechanical operation step by step and illustrated it with the use of sketches. Read the operations - trace out on the sketches and on the machine. Go over and over until you have a mental picture of the parts that perform multiplication.

SELECTION AND ESCAPEMENT:

The small keyboard is used for entering the figures of the multiplier. By reading the figures to be entered from left to right and depressing the selection keys, the figures will appear in the multiplier dials.

The multiplier keyboard consists of 9 numeral selection keys, 1 zero key, the multiply key, the accumulate multiply key, the negative multiply key, and the multiply clear key. The keyboard also has an escapement rod located under the selection keys between the top and bottom plates and in the approximate center of the keyboard. The escapement pawls are located at the rear of the keyboard.

The movable multiplier unit consists of segments and a pinboard. The pinboard has the setting pins. There are 10 or 8 columns of 8 pins each and there are 10 or 8 segment latches. There is also an escapement comb and located under the keyboard are 8 setting levers.

SELECTION AND ESCAPEMENT: (cont'd)

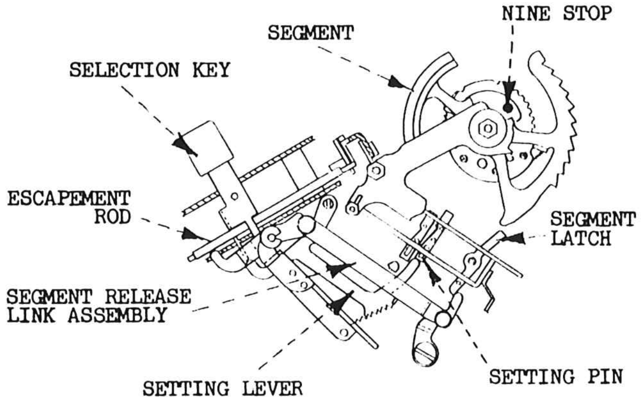


FIG. 1

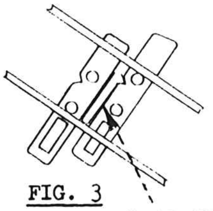


FIG. 3

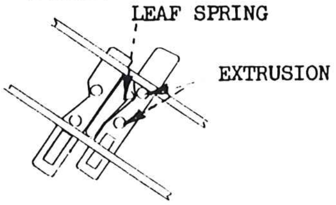
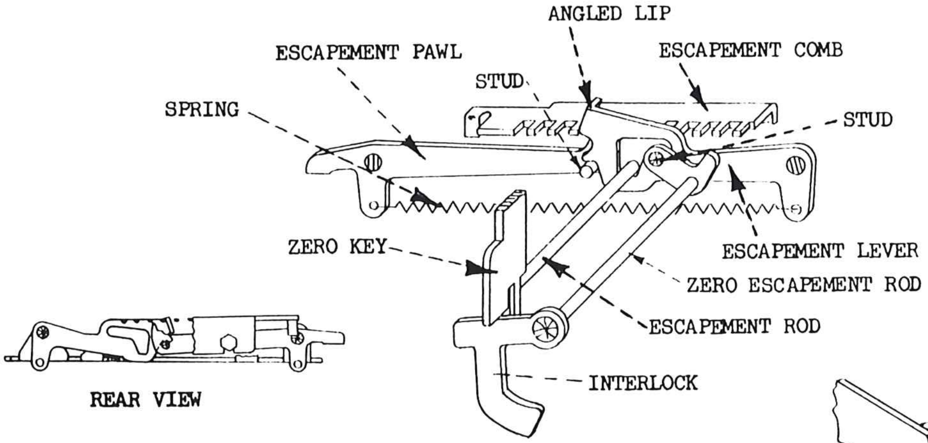


FIG. 2

SKETCH 60

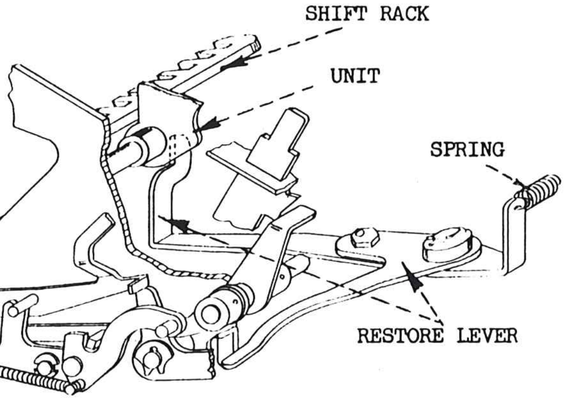
The depression of the number 3 selection key will cause:

1. The #3 setting lever to be actuated into contact with the number 3 setting pin, Sketch 60, Fig. 1. The setting pin is raised and detented into position by the leaf spring. Fig. 3 shows one style of leaf spring; Fig. 2 shows a revised style. The extrusion on the pins limit the motion between the pinboard plates.
2. The escapement rod to actuate the segment release link assembly. The rear of the link assembly will actuate the segment latch from under the segment and the segment will rotate by spring action until stopped by the raised setting pin.



SKETCH 61

FIG. 1



SKETCH 61

FIG. 2

3. The rear of the escapement rod to actuate the escapement lever downward, Sketch 61, Fig. 1. The escapement lever will contact the stud on the escapement pawl and depress it below the tooth of the escapement comb. When this occurs the unit will "hop" slightly to the left by spring action on the restore lever, Sketch 61, Fig. 2. The unit is stopped by a comb tooth contacting the angled lip of the escapement lever which was depressed into a tooth space of the comb.

SELECTION AND ESCAPEMENT: (cont'd)

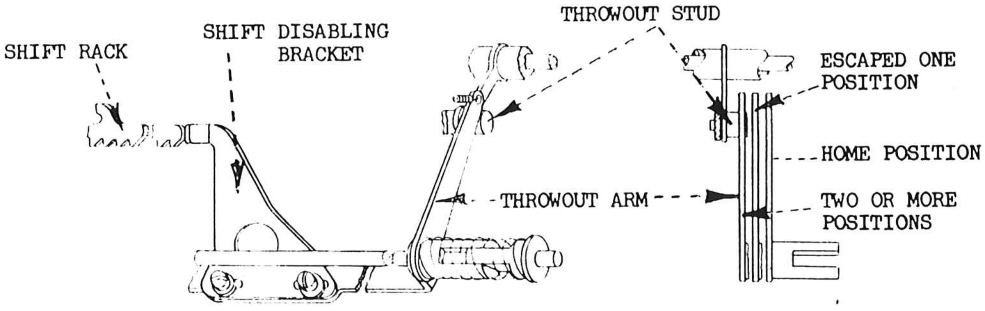
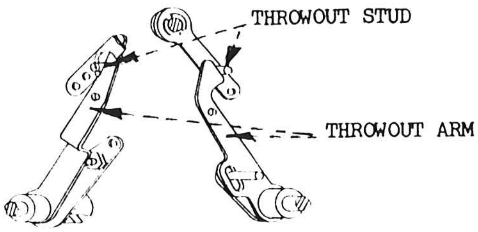


FIG. 2 (Early Style)



SKETCH 62

FIG. 3 (Revised Styles)

The restore of the selection key will cause: (simultaneously)

1. The return of the escapement rod and the raising of the escapement lever by action of the spring between the escapement pawl and the escapement lever. When this angled lip raises, the unit will move more to the left and when the angled lip leaves the comb tooth, the unit will escape the full position. The unit is stopped by the escapement pawl raising into a comb tooth space as the escapement lever raises. When the unit moves to the left by spring action on the restore lever, the shift disabling bracket, Sketch 62, Fig. 2 and 3, moves also. This allows the throwout arm to move to the left. One escapement will position the throwout arm next to the throwout stud; two escapements will position the arm over the stud.
2. As the escapement rod restores, the segment release link will restore so it will not contact the side of the next order segment latch.
3. As the selection key restores by spring action, the setting lever will restore by spring action so the setting lever will not contact the side of the next order setting pin.

ZERO SELECTION:

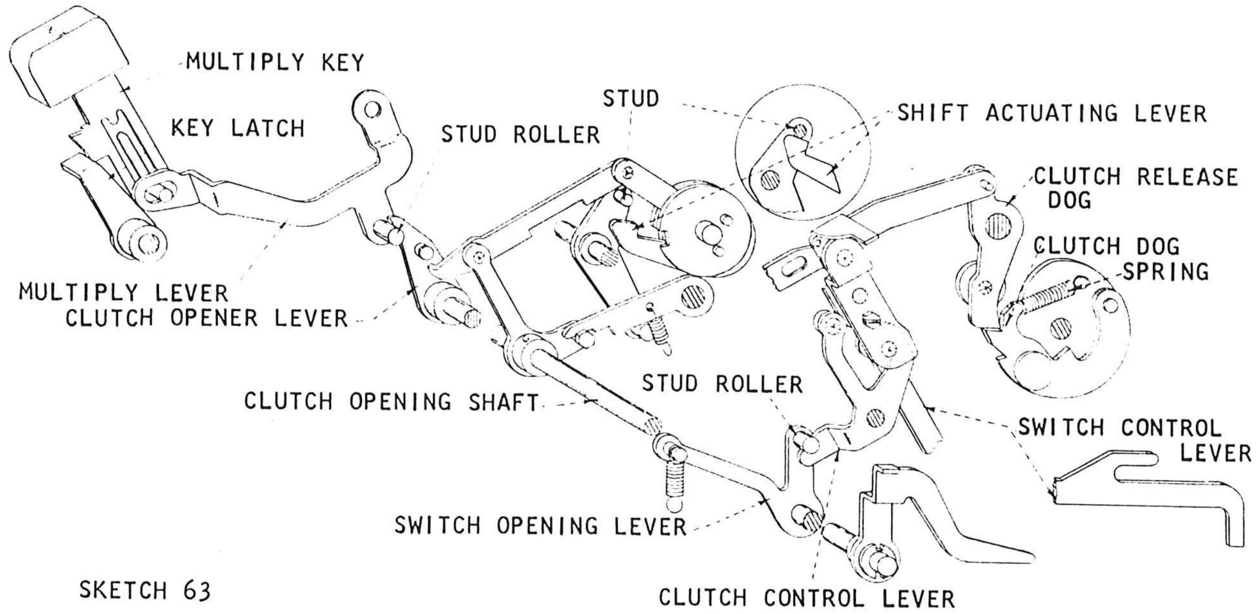
The depression of the zero key, Sketch 61, Fig. 1, will cause the interlock to rotate the shaft to the escapement lever. The stud fitted into the escapement lever will cause the lever to depress. This will cause the escapement pawl to go below the comb tooth and the unit will "hop" and stop because of a comb tooth contacting the angled lip of the escapement lever. This is the same action as on selection. The restoring of the zero key will cause the unit escapement the same as on selection. The zero key does not cause the setting of a pin or the releasing of a segment. It escapes the unit only.

NUMBER 9 KEY SELECTION AND ESCAPEMENT:

The depression of the #9 selection key causes:

1. The escapement rod to actuate the escapement as for a numeral key.
2. The escapement rod to actuate the segment release link to release a segment as from a numeral key. Since there is no #9 setting lever on a setting pin, the segment will rotate to the 9 stop, Sketch 60, Fig. 1. The restore of the #9 key will cause the same action that occurs from the other selection keys.

MULTIPLY KEY - CLUTCH RELEASING:



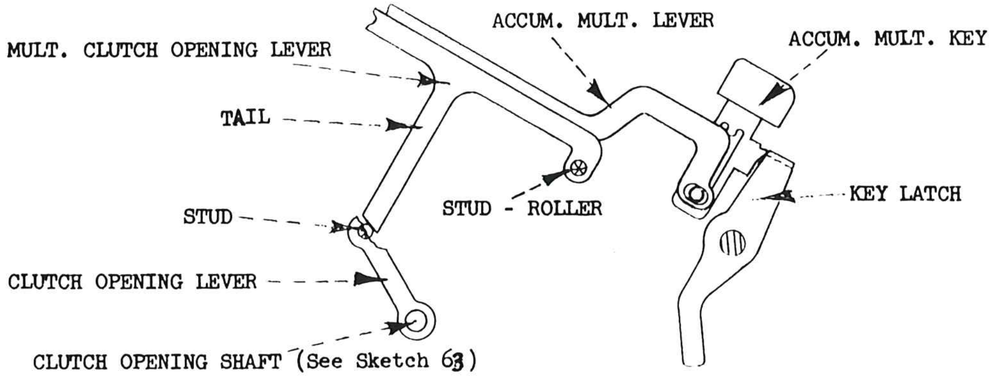
SKETCH 63

The depression of the multiply key will actuate the multiply lever, Sketch 63. A stud and roller on the rear of the lever contacts the clutch opener lever. This will cause the clutch opening shaft to rotate. At the right end of the shaft the stud and roller on the switch opening lever actuates the clutch control lever thus actuating the lower end of the shift contact and levers assembly. This assembly is connected to the clutch release dog and actuates the clutch release dog from the clutch dog. The clutch dog moves in to engage the ratchet gear of the main drive gear by spring action. At the same time the micro switch is closed by the switch control lever.

The rotation of the clutch opening shaft will position the shift actuating lever next to the stud on the shift shaft oscillating lever the same as on the Carriage Clear Key.

The key is latched down by the key latch.

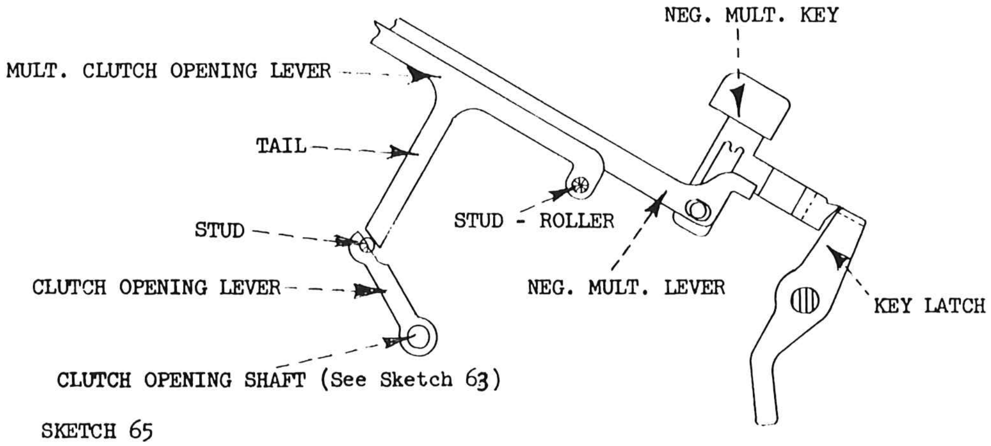
ACCUMULATE MULTIPLY KEY - CLUTCH RELEASING: (Sketch 64)



SKETCH 64

The depression of the accumulate multiply key depresses the accumulative multiplier lever. This lever contacts a roller and stud on the multiplier clutch opening lever and depresses the lever. The tail contacts a stud on the clutch opening lever rotating it so the clutch opening shaft is rotated. The parts attached to the clutch opening shaft cause the switch closing, the clutch releasing, and the positioning of the shift actuating lever the same as on the multiply key, Sketch 63. The key is latched down by the key latch.

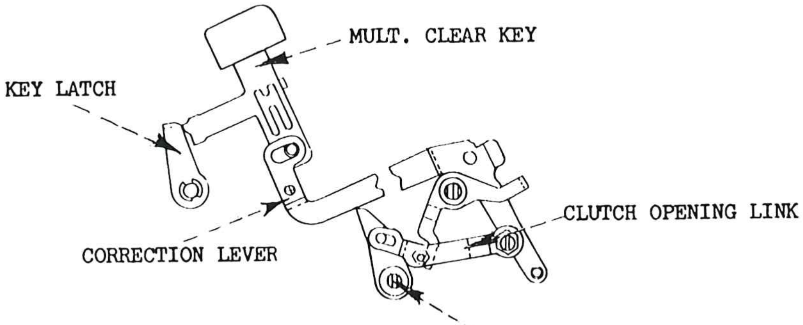
NEGATIVE MULTIPLY KEY - CLUTCH RELEASING: (Sketch 65)



SKETCH 65

The depression of the negative multiply key depresses the negative multiplier lever. This lever contacts the roller and stud on the multiplier clutch opening lever. The action from this point is the same as on the accumulate multiply key. The key is latched down by the key latch.

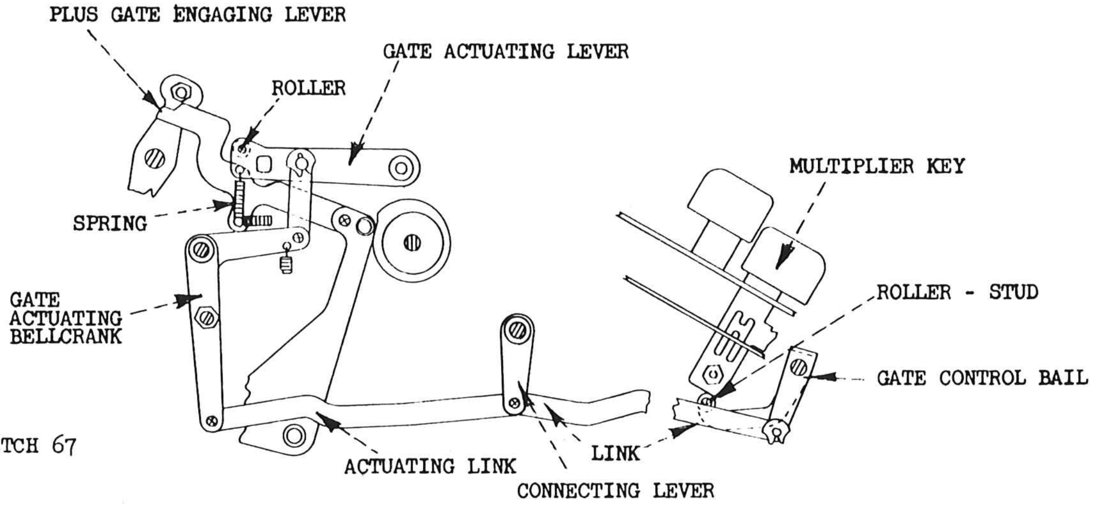
MULTIPLIER CLEAR KEY - CLUTCH RELEASING: (Sketch 66)



SKETCH 66

The depression of the multiplier clear key actuates the correction key lever. Attached to the lower rear of the lever is the correction key clutch opening link. The link is moved rearward and the front end of the link rotates the clutch opener lever by a stud. This action rotates the clutch opening shaft and the parts attached to the shaft cause the switch closing, clutch releasing, and positioning of the shift actuating lever. The key is latched down by the key latch.

PRESETTING OF GATE ENGAGING LEVER:

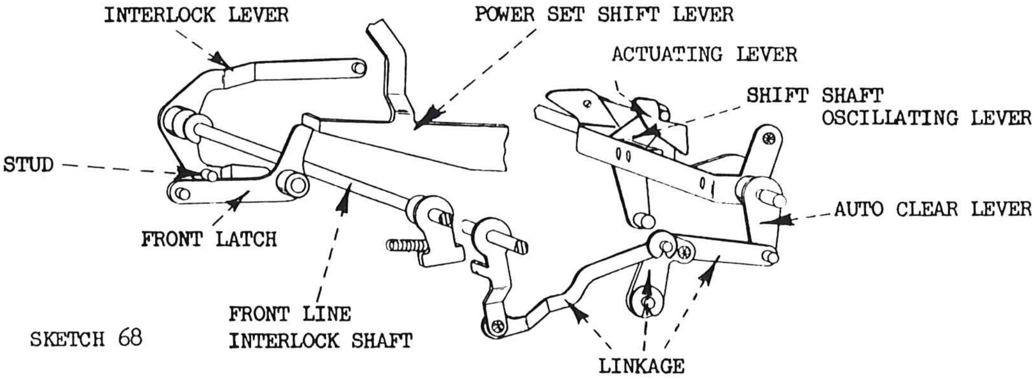


SKETCH 67

Using the hand crank shift the carriage to the fifth position. Have the add key down. Set $111.11 in the main keyboard and select $210.23 in the multiplier keyboard. The depression of the multiplier key:

1. Closes the switch, releases the clutch, Sketch 63.
2. Positions the shift actuating lever to the stud of the shift oscillating lever, Sketch 63.
3. Contacts the roller and stud on the gate control bail thus actuating the bail, Sketch 67. The bail pulls a link forward; the rear of the link is attached to the connecting lever and attached to this is the actuating link. The forward motion of the links actuate the gate actuating bellcrank. This in turn raises the gate actuating lever, moving the roller from the plus engaging lever and stretches the spring to the engaging lever.

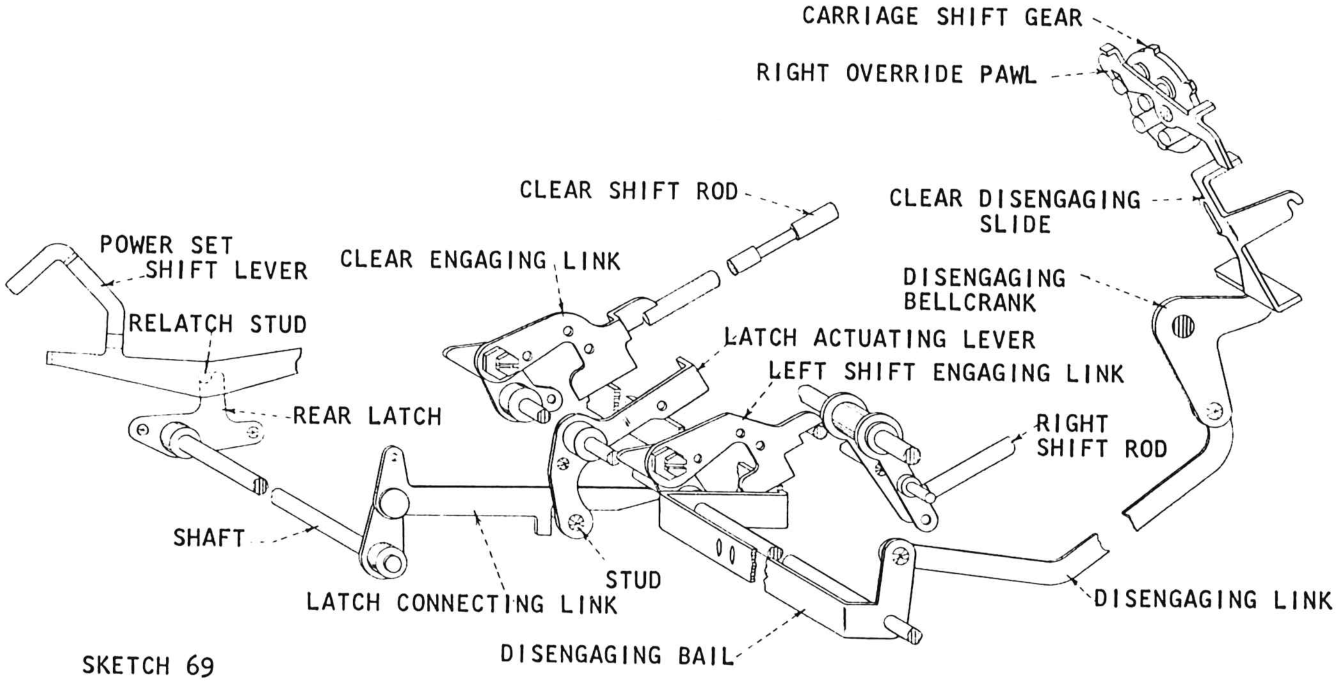
DELATCHING OF FRONT LATCH:



SKETCH 68

Rotate the drive shaft by the hand crank. As the drive shaft rotates, the shift actuating lever picks up the stud on the shift oscillating lever. The left shift and the carriage clear is set up the same as in Sketch 22. At the same time the shift rods are positioned, the auto clear lever moves the linkage connected to the front line interlock shaft to the front, Sketch 68. The shaft is rotated and the interlock lever is moved. A stud on the lower arm moves the front latch from under the lip of the power set shift lever.

DELATCHING OF REAR LATCH:



SKETCH 69

Continued rotation of the drive shaft will shift the carriage to first position. The carriage will clear per Sketch 24 and 25. When the override action occurs, the carriage shift gear, Sketch 69, actuates the right override pawl and the pawl depresses the clear disengaging slide which rotates the clear disengaging bail. The left end of the bail moves the latch actuating lever. The stud on the lower end of this lever moves the latch connecting link to the rear and through its shaft moves the rear latch from under the relatch stud of the power set shift lever. The bail also disengages the left shift engaging link and the carriage clear link.

POSITIONING OF FEED PAWL, POWER SET CAM, GATE ENGAGING LEVER:

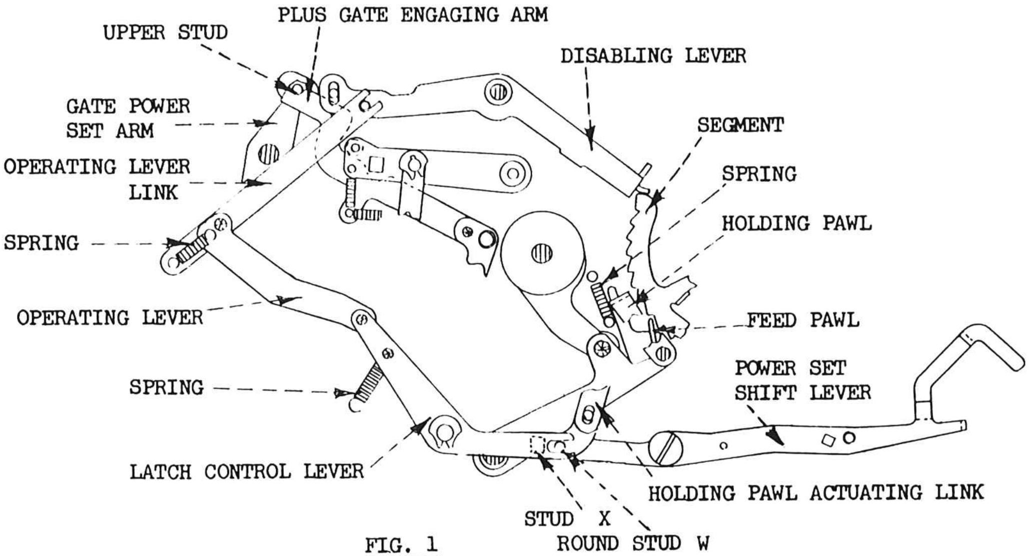


FIG. 1

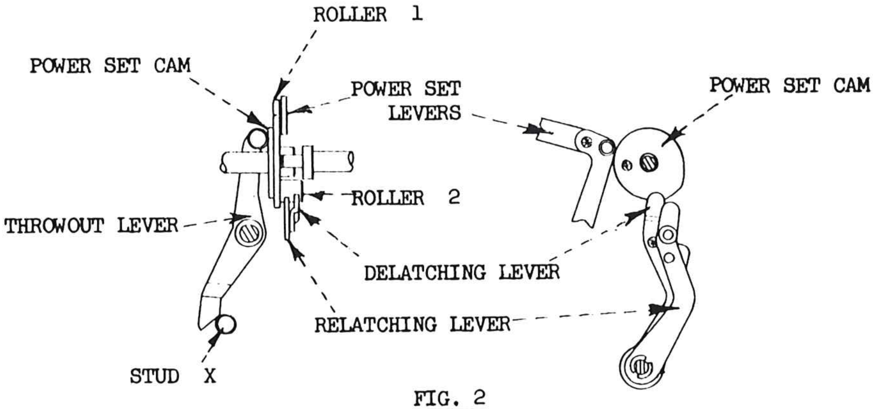


FIG. 2

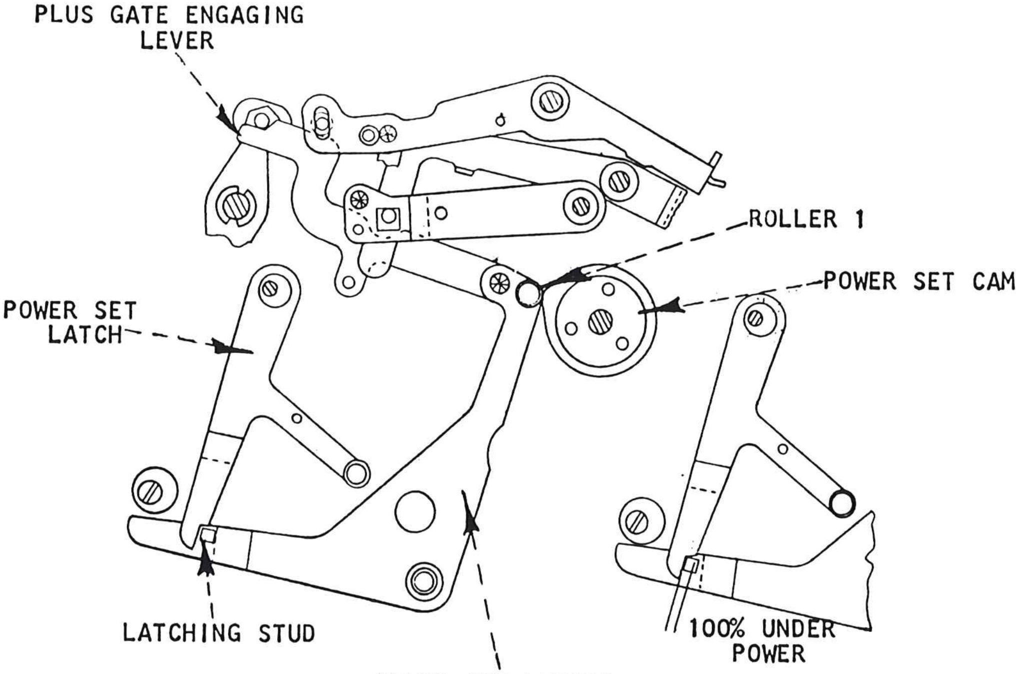
SKETCH 70

When the rear latch is disengaged, the power set shift lever drops - front end down - rear end up by action of the spring on the latch control lever Sketch 70, Fig. 1. This action causes the following: (simultaneously)

1. Stud W at the rear side of the power set shift lever raises the holding pawl actuating link which allows the spring on the holding pawl arm to rotate the holding pawl shaft assembly and positions the holding pawl into engagement with the segment. The forward movement of the holding pawl brings the feed pawl into position for feeding out a segment.
2. Stud X at the rear of the power set shift lever actuates the throwout lever, Fig. 2 so the upper end pushes the power set cam to the right. This brings roller 2 on the power set cam into position over the delatching and the relatching levers and positions the cam in front of the roller 1 on the power set levers.
3. A stud at the rear of the latch control lever, Fig. 1, actuates the operating lever, which raises the operating lever link by a spring. The upper end of the link pushes on the disabling lever. The front end will depress and the rear end will raise and allow the plus gate engaging lever to raise by spring action for engagement with the upper stud of the gate power set arm, Fig. 1.

When the preceding is completed all parts are now ready to perform the calculation which now follows.

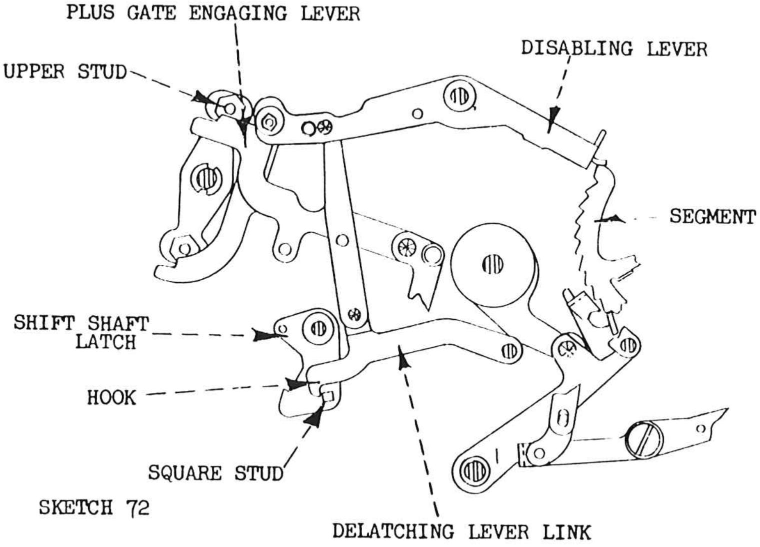
ADD-SUBTRACT GATE ENGAGING:



SKETCH 71

The continued cycling of the drive shaft will cause the lobe of the power set cam to contact Roller 1 on the power set levers, Sketch 71. The plus gate engaging lever will position the add-subtract gate in the add position. The cycle lock pin will be to the rear of the cycle lock disc (not shown). As the power set lever is moved by the power set cam, the lower end drops and the power set latch moves over the latching stud. This latch holds the gate into position as the power set cam cycles to prevent bouncing. Under power the latch will engage 100%.

FEED OUT OF SEGMENT:



SKETCH 72

Continued rotation of the drive shaft will cause the feed pawl by its eccentric to feed out the segment one digit at a time, Sketch 72. As the segment is raised, the holding pawl drops into the next lower tooth space, therefore, the segment cannot drop back when the feed pawl moves down. Each cycle corresponding to the segment feed will add the main keyboard figure one time into the upper dials and will rotate the counter dial one digit. Rotate the drive shaft 3 times to feed out the right segment. When the segment feeds to zero the lip of the disabling lever is raised. This causes:

1. The rear of the lever to position the hook of the shift shaft delatching lever over the square stud or lip of the shift shaft latch. (The hook was raised when the power set shift lever dropped).
2. The rear of the disabling lever to disengage the plus gate engaging lever from the upper stud. When this occurs, the add-subtract gate is held in position by the cycle lock pin against the cycle lock disc until the disc rotates to the cutout.

CARRIAGE SHIFT AND UNIT SHIFT:

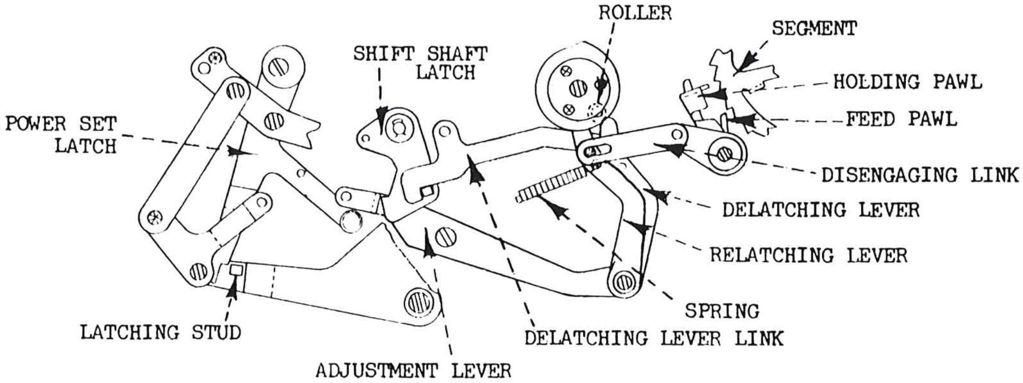


FIG. 1

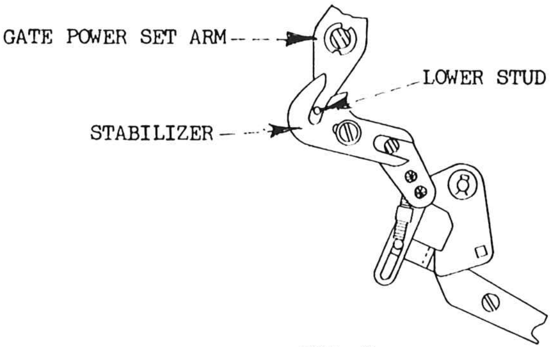
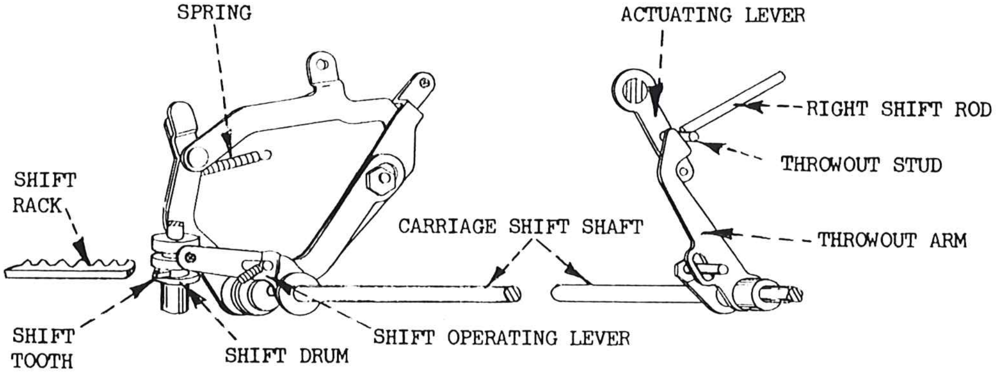


FIG. 3



SKETCH 73

FIG. 2

Continued rotation of the drive shaft will bring the roller on the power set cam into contact with the delatching lever, Sketch 73, Fig. 1. As the delatching lever is moved to the front, the hook of the shift shaft delatching lever pulls the shift shaft latch from under the adjustment lever. When this occurs the adjustment arm drops by spring action:

1. The adjustment arm disables the power set latch from the latching stud on the power set lever, Fig. 1.
2. The carriage shift shaft is rotated by spring to cause, Fig. 2:
   a. The shift throwout arm to contact the throwout stud of the actuating lever. The stud in turn moves the right shift rod to the rear. This will position the parts for a right shift.
   b. The raising of the shift drum to position the shift tooth into the shift rack.
3. The adjustment arm positions the stabilizer over the lower stud of the gate control arm, Fig. 3, as the gate centralizes.
4. The adjustment arm causes the relatch lever to move rearward and through a link disables the holding pawl and feed pawl from the segment, Fig. 1.

CARRIAGE SHIFT AND UNIT SHIFT:

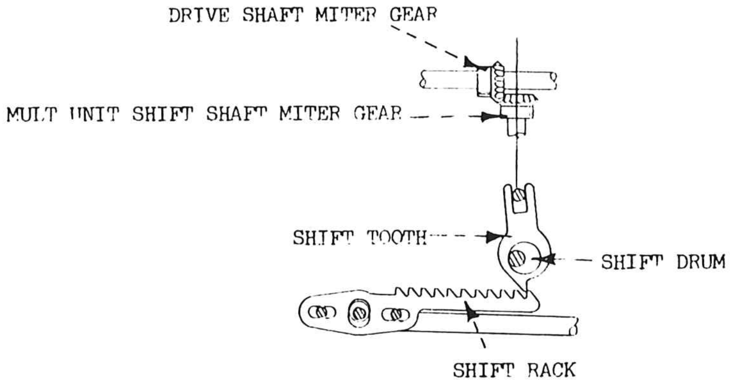
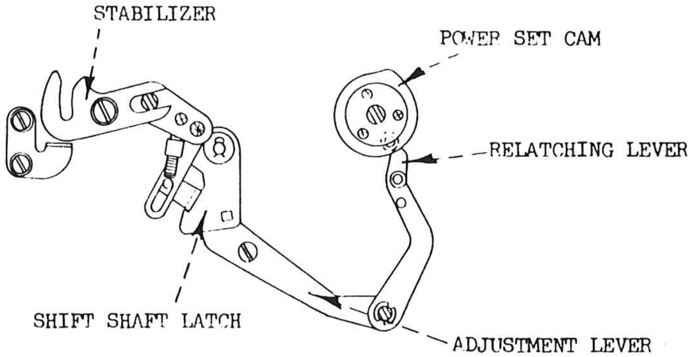


FIG. 1



SKETCH 74

FIG. 2

Continued rotation of the drive shaft will cause:

1. The right carriage shift.
2. The right unit shift by the rotation of the shift drum. The miter gear on the drive shaft, Sketch 74, Fig. 1, turns the miter gear on the multiplier unit shift shaft. The rotation of the shift shaft turns the shift drum which is eccentric and causes the shift tooth to contact the shift rack and feed the unit one position to the right. As the unit moves to the right then the escapement pawl will be cammed below the tooth on the escapement comb and then will rise into the next tooth space of the comb. This is to prevent the unit from dropping back to the left when the shift tooth leaves the shift rack. As the unit shifts to the right, the lip of the disabling lever drops off into the space of the next selected segment. When this occurs, the rear of the lever raises the hook off the stud or lip of the shift shaft latch and allows the plus gate engaging lever to engage the upper stud of the gate control arm.
3. The roller on the power set cam to actuate the relatch lever.
   a. This results in the restoring of the stabilizer and latching of the adjustment arm, Sketch 74, Fig. 2.
   b. This restores the shift drum and tooth and restores the shift throwout arm to allow the restoring of the right shift push rod.
   c. This engages the holding pawl and feed pawl with the segment.

Continued rotation of the drive shaft will cause the power set cam to again actuate the power set lever. The plus gate engaging lever and the gate will be moved to the rear. The same action will again occur that has been covered except the segment will be fed out two digits. When the disabling lever is raised by the segment the carriage shift and the unit shift will again occur. Trace this out as the action occurs.

Now, since the next segment has a zero the disabling lever cannot drop as the unit shifts. Therefore, the hook of the shift shaft delatching lever will keep the shift shaft latch from under the adjustment arm as the adjustment arm is restored. This is accomplished by the roller on the power set cam. The adjustment arm will again drop when the roller on the power set cam leaves the relatch lever, and again a resulting carriage shift and the unit shift will occur. When the unit shifts again to the right the disabling lever will drop and the actions of the parts will be the same as before while the segment is fed out one digit. Trace these actions as they occur while you rotate the hand crank.

When the segment is restored to zero the actions as mentioned will again occur. Trace them.

UNIT SHIFT TO HOME POSITION:

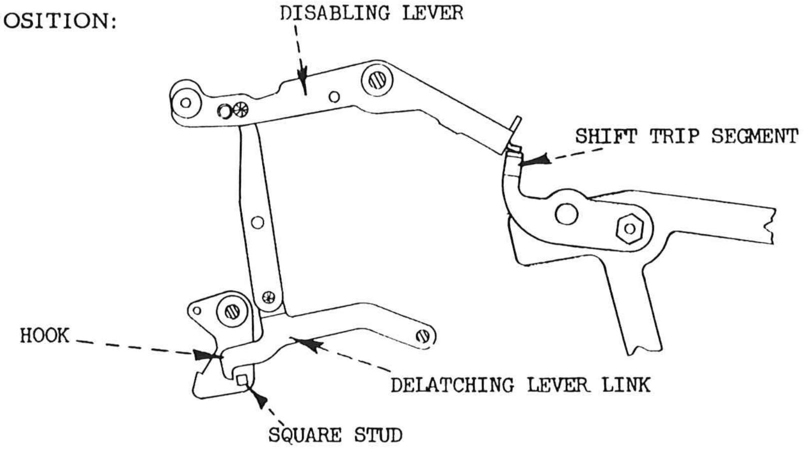
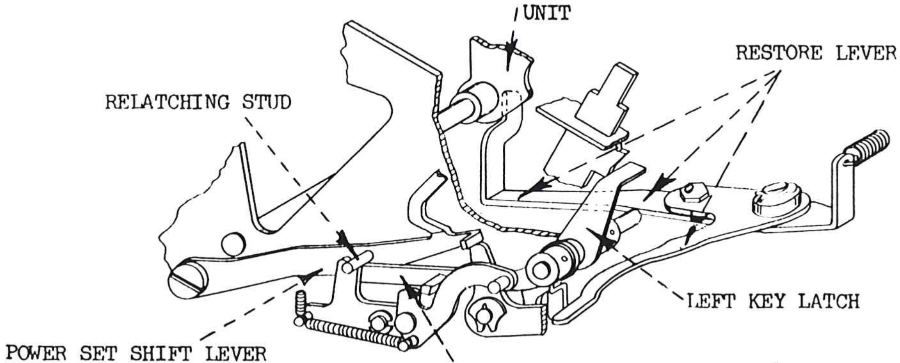


FIG. 1



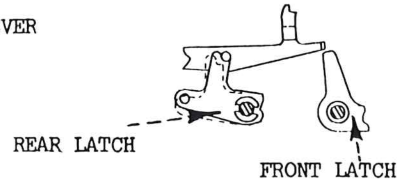


FIG. 2

SKETCH 75

Now as the unit shifts after feeding the segment that had the one digit, the end of the shift rack moves the shift disabling bracket to the right. Attached to the bracket is a bail and this bail moves the shift throwout arm to the right and off the throwout stud. This is to insure no carriage shift as the last segment is fed to zero.

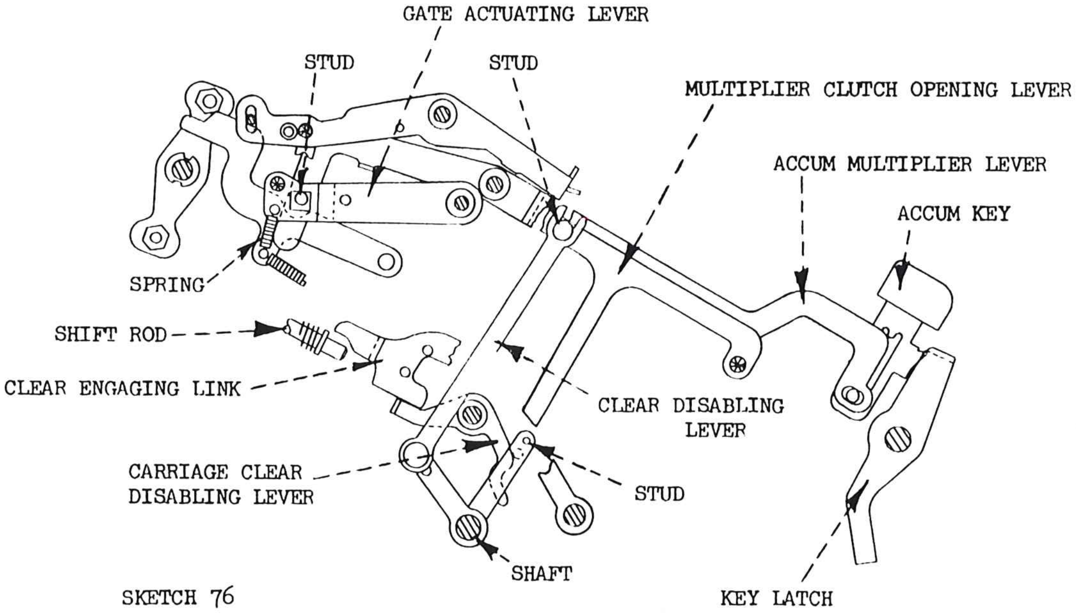
Continue to rotate the drive shaft to feed out the last segment. When the segment reaches zero, the actions occur as mentioned before. The carriage does not shift and the unit does shift. As the unit shifts, the shift trip segment moves under the lip of the disabling lever, Sketch 75, Fig. 1. This is to hold the disabling lever up to keep the hook of the shift shaft delatching lever over the stud or lip of the shift shaft latch, so the carriage shift shaft can delatch again to obtain one more unit shift.

When the last unit shift occurs, the unit contacts the restore lever and moves it. The restore lever contacts the left key latch: (Sketch 75, Fig. 2).

1. The left key latch actuates the key latches from the keys. The depressed key is released. This causes:
   a. The delatching of the oscillating latch.
   b. The restore of the front line interlock shaft, the release of the front latch and the positioning of the keyboard clear link.
   c. The release of the clutch release dog to allow the clutch to open and the switch to open at the end of the drive shaft cycle.
2. Attached to the shaft of the key latch assembly is the relatch lever. This lever raises the power set shift lever by the relatch stud so the rear latch and the front latch can move under the power set shift lever. When the power set shift lever restores, all of the parts positioned by it will be restored to home position.

As the drive shaft completes its cycle the keyboard is cleared, the adjustment arm is relatched onto the shift shaft latch, the clutch is disengaged and the switch opened to stop the drive shaft.

MULTIPLICATION FROM THE ACCUMULATE MULTIPLY KEY:



SKETCH 76

You have gone through the complete multiplication operation by using the multiply key. Now we will go through an accumulate multiplication operation. In accumulate multiplication there is no carriage clear operation and the gate engaging lever is initially released by a different lever than on the multiply key.

Use the same keyboard set up as you used on the multiply key. The depression of the accumulate multiply key: (Sketch 76).

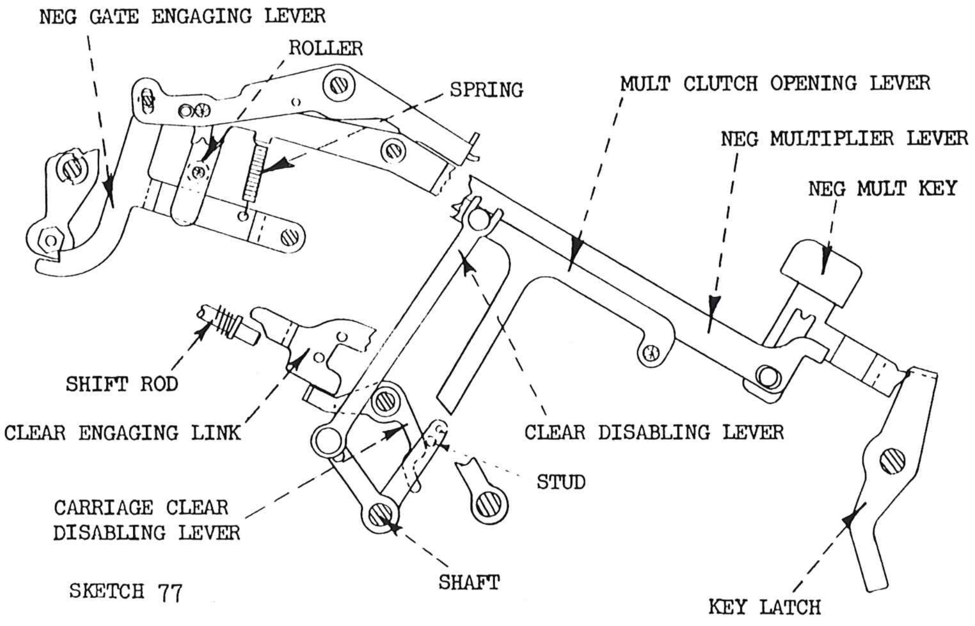
1. Closes the switch and releases the clutch, Sketch 63 and 64.
2. Positions the shift actuating lever to the stud of the shift oscillating lever, Sketch 63.
3. Actuates the multiplier clutch opening lever. Located approximately center of this lever is a stud. Connected to this stud is the clear disabling levers assembly. The movement of the clutch opening lever depresses the clear disabling lever and through its shaft actuates the clear disabling lever. A stud on this lever contacts the carriage clear disabling lever. This lever raises the clear engaging link above the carriage clear shift rod.
4. Actuates the accumulate multiplier lever and at the rear of this lever is a stud that fits into the square hole of the gate actuating lever. As the rear of the lever is raised, the gate actuating lever is raised and the spring between the actuating lever and the plus gate engaging lever is stretched.

ACCUMULATE MULTIPLICATION:

Rotation of the drive shaft will cause:

1. The actuating lever to pick up the stud on the shift oscillating lever.
    - a. The left shift is set up, Sketch 22, but no carriage clear.
    - b. The linkage to the front line interlock shaft is operated, Sketch 68. The front latch is delatched.
2. The carriage to shift to first position.
    - a. The override will occur to disable the rear latch, Sketch 69, and to delatch the left shift engaging link. The power set shift lever will drop, Sketch 70, Fig. 1. The feed pawl and holding pawl are engaged with the segment. The plus gate engaging lever is engaged with the upper stud of the gate power set arm. The power set cam is positioned over the relatch and delatch levers.
3. The power set cam will operate the power set lever, Sketch 71.
4. The feed pawl to feed out the segment, Sketch 72. The disabling lever will be operated to place the hook over the stud or lip of the shift shaft latch and to disengage the plus gate engaging lever.
5. The roller on the power set cam to actuate the delatching lever, Sketch 73.
    - a. The shift shaft latch will be delatched.
    - b. The adjustment arm will drop. The power set latch is delatched.
    - c. The feed pawl and holding pawl will be disengaged from the segment.
    - d. The carriage shift shaft is operated to position the right shift rod and the unit shift tooth.
6. The right carriage shift and the unit shift, Sketch 74.
7. The adjustment arm to latch up; the carriage shift shaft to restore.
8. The power set cam to operate the power set levers again and the gate is positioned.
9. The segment is fed out again and the action is per Sketch 74.
10. The feeding out of the last segment and the last unit shift is the same as in Sketch 75 and the machine will stop.

MULTIPLICATION FROM THE NEGATIVE MULTIPLY KEY:



SKETCH 77

We will now go through the mechanical operation that accomplishes a negative multiplication. You will find the actions identical to multiply and accumulate multiply with these exceptions: That the negative gate engaging lever is positioned in place of the plus gate engaging lever and the add-subtract gate is placed in the subtract position. The carriage does not clear on negative multiplication.

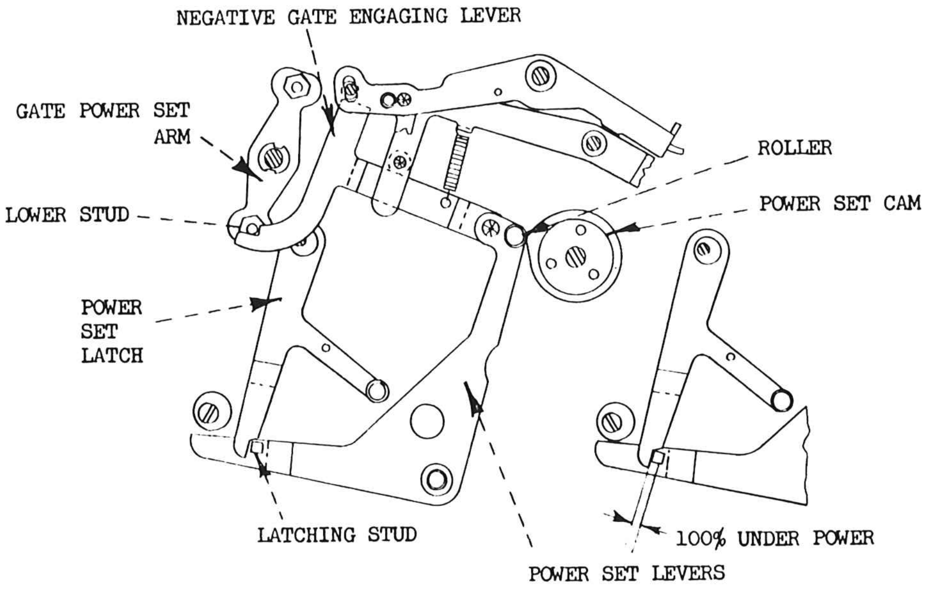
Use the same keyboard set up as you used on the multiply key. The depression of the negative multiply key:

1. Closes the switch and releases the clutch, Sketch 63 and 65.
2. Positions the shift actuating lever to the stud of the shift oscillating lever, Sketch 63.
3. Raises the clear engaging link above the clear shift rod, Sketch 77.
4. Actuates the negative multiplier lever, raising the rear to move the roller away from the negative gate engaging lever. This action stretches the spring between the two parts, Sketch 77.

NEGATIVE MULTIPLICATION:

Rotation of the drive shaft will cause:

1. The shift actuating lever to pick up the stud on the shift oscillating lever.
   a. The left shift is set up, Sketch 22 but no carriage clear.
   b. The linkage to the front line interlock shaft is operated, Sketch 68. The front latch is delatched.

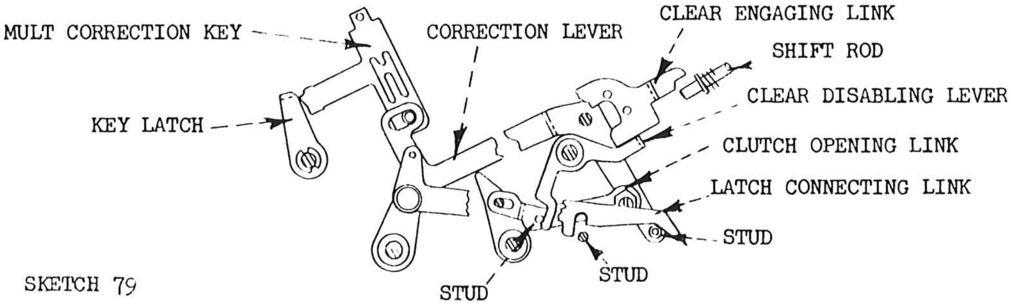


SKETCH 78

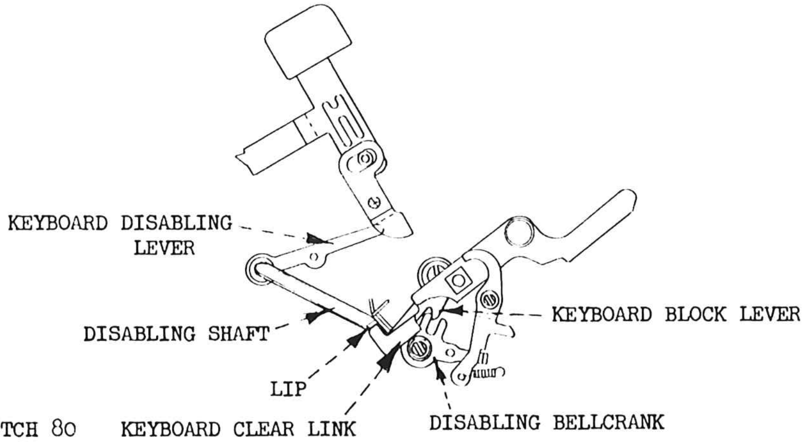
2. The carriage to shift to first position.
   a. The override will occur to disable the rear latch, Sketch 69, and to delatch the left shift engaging link. The power set shift lever will drop, Sketch 70, Fig. 1. The feed pawl and holding pawl are engaged with the segment. The negative gate engaging lever is engaged with the lower stud of the gate power set arm Sketch 78. The power set cam is positioned over the relatch and delatch levers.
3. The power set cam will contact the roller on the power set lever which will cause the negative gate engaging lever to position the add-subtract gate into subtract position, Sketch 78.
4. The feed pawl to feed out the segment, Sketch 72. The disabling lever will be operated to place the hook over the stud or lip of the shift shaft latch and to disengage the negative gate engaging lever.
5. The roller on the power set cam to actuate the delatching lever, Sketch 73.
   a. The shift shaft latch will be delatched.
   b. The adjustment arm will drop. The power set latch is delatched.
   c. The feed pawl and holding pawl will be disengaged from the segment.
   d. The carriage shift shaft is operated to position the right shift rod and the unit shift tooth.
6. The right carriage shift and the unit shift, Sketch 74.
7. The adjustment arm to latch up, the carriage shift shaft to restore.
8. The power set cam to operate the power set levers again and the gate is positioned in subtract.
9. The segment is fed out again and the action is per Sketch 74.
10. The feeding out of the last segment and the last unit shift is the same as in Sketch 75 and the machine will stop.

MULTIPLY CORRECTION:

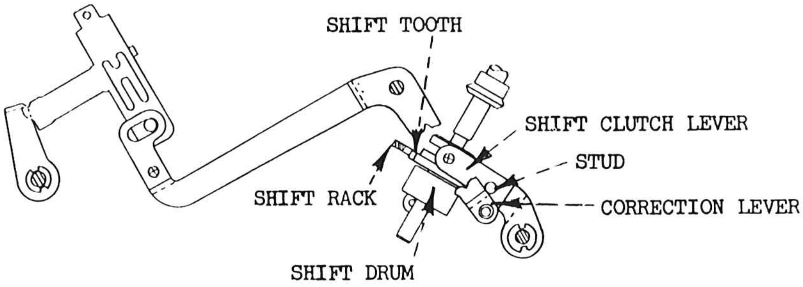
Multiply correction is an operation that automatically clears the selection from the unit without causing a registration in the upper and lower dials or a carriage clear. On the STW, ACG, SRW, the correction operation feeds the unit to the right. On the gray line models, ST, S, it causes the feeding out of each segment.



SKETCH 79



SKETCH 80



SKETCH 81

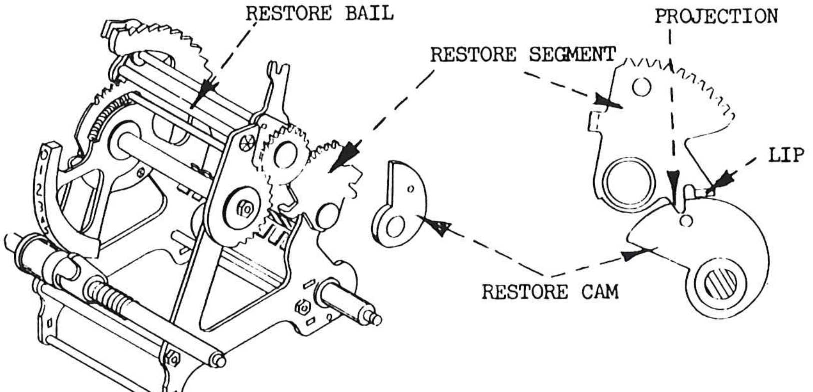
Use the same keyboard set up as you used on the multiply key. The depression of the multiply correction key:

1. Closes the switch and releases the clutch, Sketch 63 and 66.
2. Positions the shift actuating lever to the stud of the shift oscillating lever, Sketch 63.
3. Actuates the correction key lever and the correction key clutch opening link. A stud on the link actuates the clear disabling lever to raise the clear engaging link above the clear shift rod, Sketch 79.
4. Causes a stud at the rear of the correction lever to raise the latch connecting link from the stud on the latch actuating lever. This is to prevent the rear latch from delatching the power set shift lever, Sketch 79.
5. Causes the lower rear of the correction lever to contact a stud on the shift clutch lever. The shift clutch lever is raised which raises the shift drum and brings the shift tooth into mesh with the shift rack, Sketch 81.
6. Actuates the keyboard disabling lever, Sketch 80. This lever being pinned to the disabling shaft rotates the shaft. At the right end, the disabling bellcrank actuates the keyboard block lever. The lip on this lever depresses the keyboard clear link below the keyboard clear gate. This prevents a keyboard clear at the end of multiply correction when the key restores.

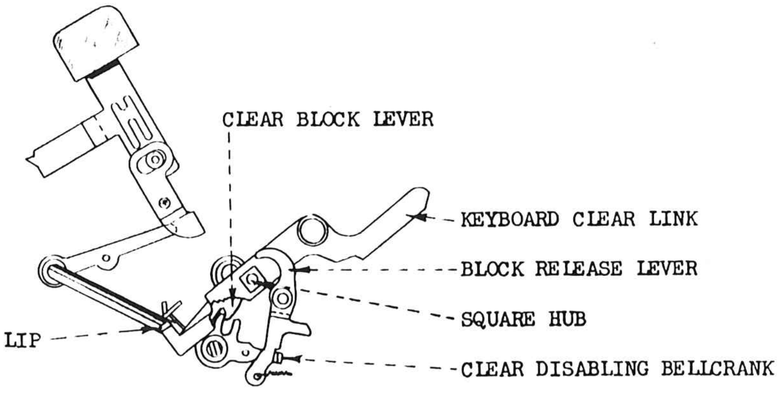
MULTIPLY CORRECTION:

Rotation of the drive shaft will cause:

1. The unit to shift one space to the right with each cycle as the unit shifts. The setting pin in each column is pulled down and this releases any tripped segment to the 9 position.
2. The shift actuating lever to pick up the stud on the shift oscillating lever.
   a. The left shift is set up, Sketch 22, but no carriage clear.
   b. The linkage to the front line interlock shaft is operated, Sketch 68. The front latch is delatched, however, this serves no purpose in multiply correction.
3. The carriage to shift left, and depending on the segment selected and the position of the carriage will move the carriage to first position and cause the override action.
   a. The override will cause the disabling of the left shift, Sketch 69, but the rear latch cannot be delatched because of the latch connection link being disengaged by the key depression. Since the rear latch does not delatch, the power set shift lever does not drop and none of the parts are positioned as in the other multiplication operations.
4. The unit will continue to shift to the right.
   a. During the first part of the last cycle of the drive shaft, the unit shifts past home position. This causes:
      (1) The unit to pick up the restore lever for actuating the key latch to delatch the multiply correction key, Sketch 75. The restore of the key releases the clutch opening shaft to delatch the oscillating latch and to release the clutch release dog so the clutch will open at the end of the cycle to stop the machine.
      (2) The restore segment to be positioned to the right of the restore cam, Sketch 82.
   b. During the last part of the last cycle the last segment is tripped to 9 and the restore cam picks up the lip of the restore segment. The actuation of the restore segment causes the restore bail to restore all tripped segments to their latches.
      (1) You'll note that during the restore of the segments, the unit will drop back to the left slightly. This is caused by the shift tooth leaving the shift rack. The shift drum will restore at this time. The unit is held in contact with the restore cam by a projection on the side of the restore segment. When the segments are restored to their latches, the unit drops to its home position because the restore cam has passed the projection of the restore segment.
   c. During the last part of the last cycle, the keyboard clear link moves rearward (when the add key is down) but the keyboard clear gate is not actuated. The lip of the clear block lever is holding the keyboard clear link below the clear gate, Sketch 83. As the clear link moves rearward the square hub contacts the block release lever and delatches this lever from the clear disabling bellcrank to allow the clear block lever to restore.
5. The drive shaft cycles to home position and the switch and clutch opens to stop the rotation.



SKETCH 82



SKETCH 83

REPEAT MULTIPLICATION (Constant Multiplier):

This operation is a feature existing on the STW, ACG and SRW models. It is a means of retaining the segments at the original selected position so that a multiplication, accumulate multiplication, or negative multiplication can be done repeatedly without changing the multiplier set up in the small keyboard and unit.

Use the same set up as you did for multiplication. Pull the repeat key forward, Sketch 84.

1. The movement of the key causes a short stud to move the actuator lever and the actuating bellcrank which actuates the selector lock into the unit position selector. The movement of the selector lock causes:
   a. A stud to allow the blockout bail to move under the multiply correction lever. This is to prevent the key depression until the repeat key is restored.
   b. The control link to pull a spring for adding tension to the escapement lever disabling slide.
   c. The ring lock bail to engage the segment ring locks through linkage.
2. The movement of the key causes a long stud to actuate the repeat interlock lever for positioning the lip to the rear of the stud on the upper arm of the interlock lever. This is to prevent movement of the key during a multiplication.
3. The key is locked in position by the contour in the actuator lever.

The depression of an operating key sets up the same functions as mentioned before. When the power set shift lever restores, the square latching stud raises the escapement pawl disabling slide (the slide was positioned over the square stud by spring tension when the power set shift lever dropped). The raising of the slide causes:

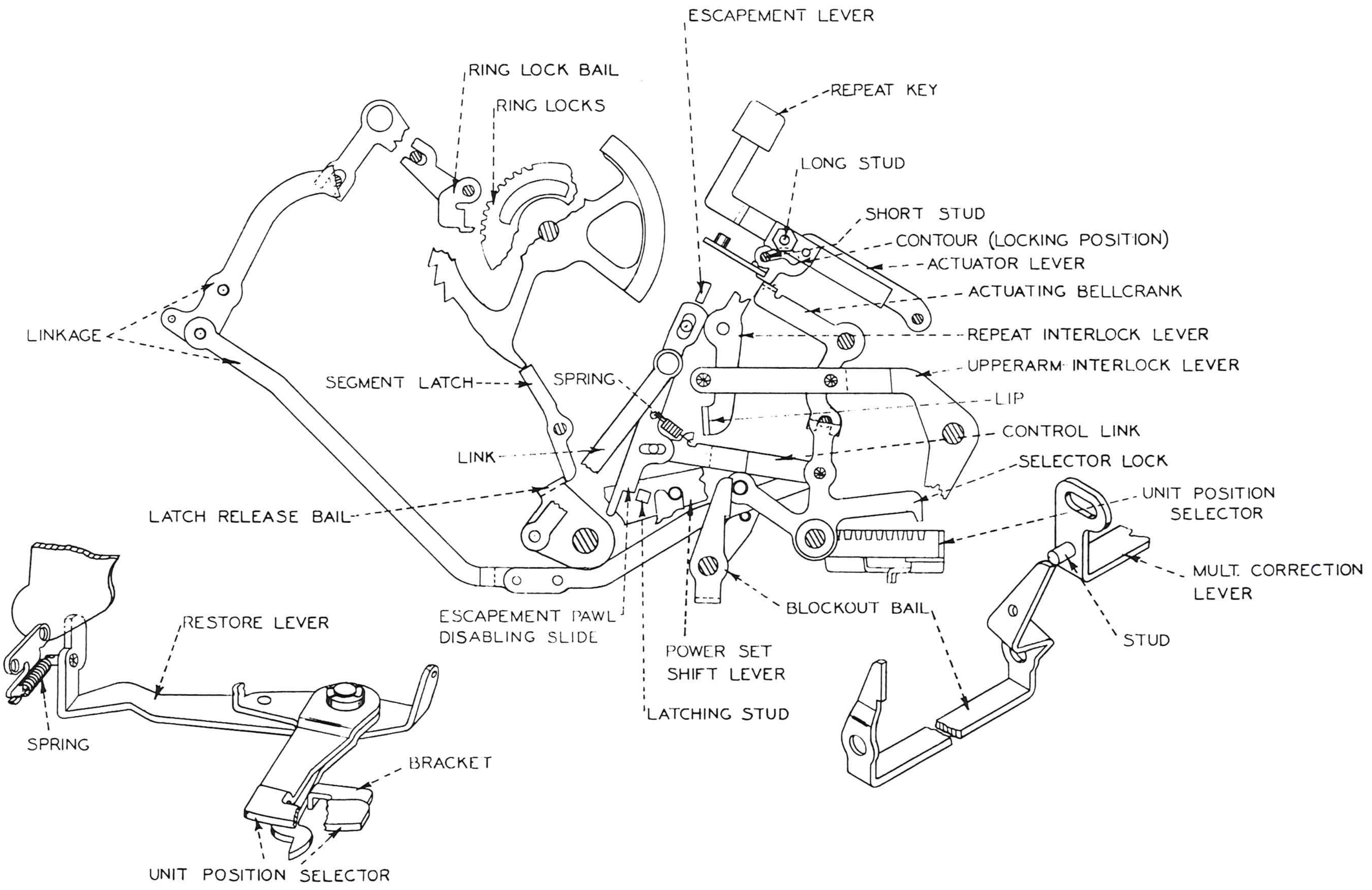
1. The upper end to press up on the tail of the escapement lever. This allows the lever to disengage from the escapement comb and the unit will move to the left until stopped, Sketch 84.
   a. The unit is stopped by the restore lever contacting the lip of the bracket on the unit position selector. The unit and the restore lever are connected by a spring that keeps the unit from going all the way to the left.
2. The link to swing the latch release bail forward so the segment latches are tripped from the segments as the unit moves to the left.
   a. As the segments are released, they rotate and stop against the ring locks which are held by the ring lock bail.

The segments are at their original selection and the unit is at its original selected position except that it is slightly further to the left because the position selector is holding it rather than the escapement lever.

To restore the repeat mechanism and the sectors, it is necessary to push the repeat key to the rear.

1. The selector lock is disabled from the unit position selector.
2. The ring lock bail is disabled from the ring locks and the segments rotate to 9's.
3. The escapement pawl disabling slide is delatched from the square latching stud and the escapement lever engages the comb.
4. The bail is removed from under the multiply correction key.

The depression of the multiply correction key will cause the unit to shift to the right for restoring the segments.


ESCAPEMENT LEVER
RING LOCK BAIL
RING LOCKS
REPEAT KEY
LONG STUD
SHORT STUD
CONTOUR (LOCKING POSITION)
ACTUATOR LEVER
ACTUATING BELLCRANK
LINKAGE
REPEAT INTERLOCK LEVER
UPPERARM INTERLOCK LEVER
SEGMENT LATCH
SPRING
LIP
CONTROL LINK
LINK
SELECTOR LOCK
LATCH RELEASE BAIL
UNIT POSITION SELECTOR
MULT. CORRECTION LEVER
ESCAPEMENT PAWL DISABLING SLIDE
BLOCKOUT BAIL
STUD
RESTORE LEVER
POWER SET SHIFT LEVER
LATCHING STUD
SPRING
BRACKET
UNIT POSITION SELECTOR

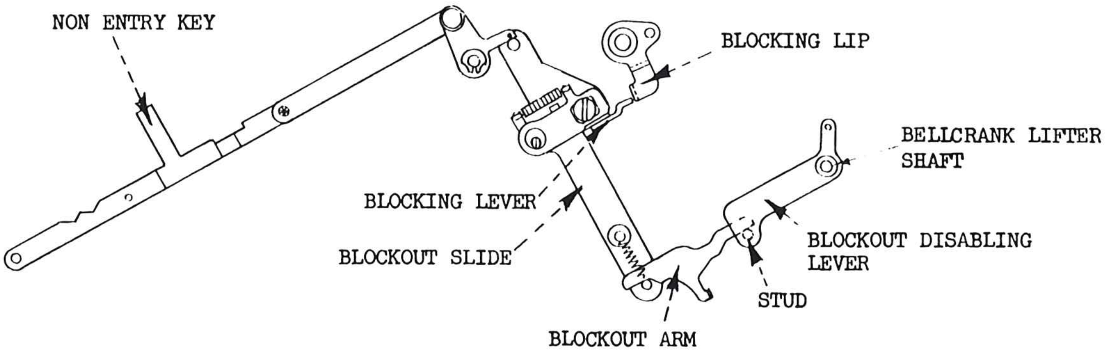
SKETCH 84

MULTIPLIER NON ENTRY:

This is a feature that prevents the counter from turning the counter dials during multiplication, addition, or subtraction. It is disabled during division to allow a counter entry.

Pulling the non entry key forward will raise the blocking lever in front of the blocking lip at the left section of the counter, Sketch 85 below. When the counter attempts to rock rearward the blocking lever contacting the blocking lip restricts the counter movement. The counter assembly is spring-loaded at the left end to prevent jamming.

The blocking lever is disabled during division at the depression of the division keys. The stud on the blockout disabling arm actuates the blockout arm which pulls down the blockout slide and the slide disables the blockout lever from the blocking lip.



SKETCH 85

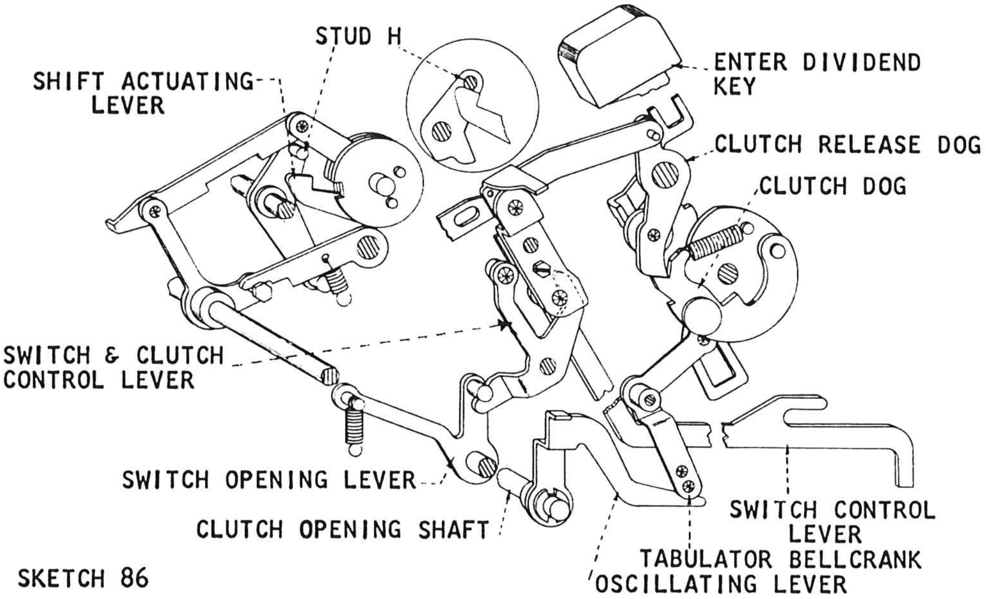
ENTER DIVIDEND:

Friden calculators are equipped with a mechanical means of automatic left shift, carriage clear, right shift, and entry of the keyboard value into the upper dials. The operation is called Enter Dividend. Its function is used in various ways but the initial use is to enter the dividend automatically into the upper dials prior to dividing.

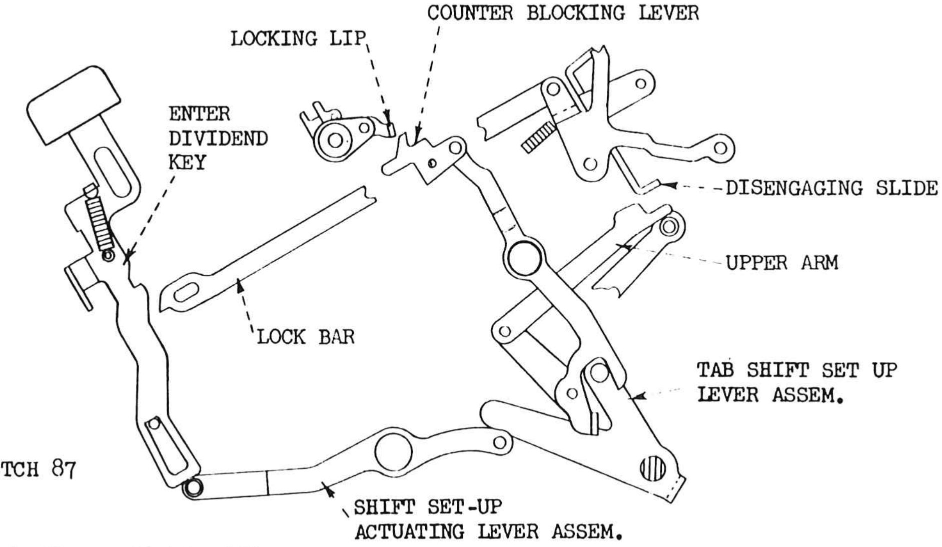
Some models are equipped with enter dividend where the carriage is stopped at a pre-selected position. Others have cross tabulation where there is no means of pre-selecting a stopping position for the carriage. On these models the carriage shifts to the extreme right after the carriage clear phase and there is no entry into the upper dials.

We will go through the Enter Dividend operation first, step by step. Read the material, check the sketches and trace out the operation on the machine.

Depress the #3 tab stop, have add key down and figures in keyboard.



SKETCH 86



SKETCH 87

The depression of the Enter Dividend Key:

1. closes the switch and releases the clutch and positions the shift actuating lever to the stud, Sketch 86.
2. positions the counter blocking lever under the locking lip of the #1 counter tooth and lock assembly, Sketch 87.
3. positions the upper arm under the disengaging slide, Sketch 87.
4. latches the key by the lock bar slipping into place, Sketch 87.

ENTER DIVIDEND: (cont'd)

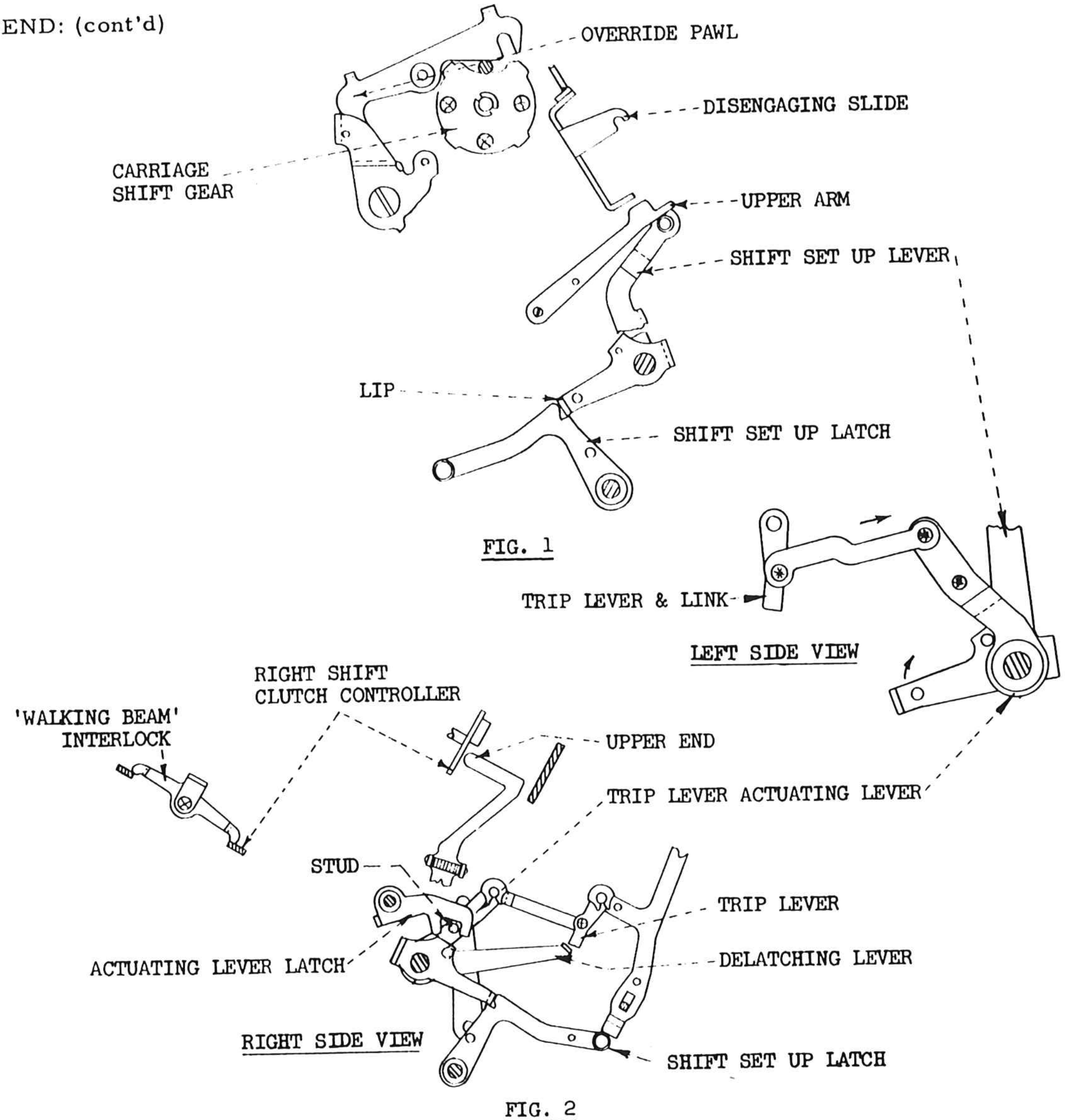


FIG. 1

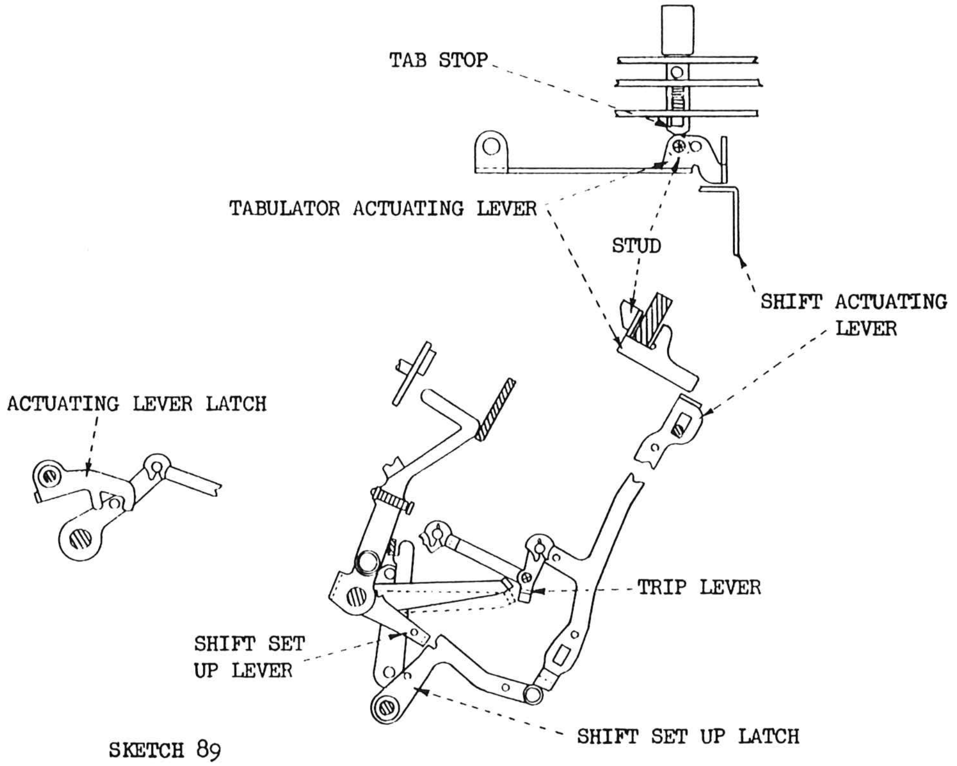
FIG. 2

SKETCH 88

The rotation of the drive shaft:

1. causes the actuating lever to pick up the stud on the shift oscillating lever and sets up the left shift and carriage clear, Sketch 22. The carriage shifts to first position and the carriage clears and the override action occurs. As the carriage shift gear rotates, it actuates the override pawl which presses on the disengaging slide, Sketch 69. The disengaging slide:
   a. actuates the disengaging bellcrank which in turn causes the left shift and carriage clear links to disengage for restoring the shift rods.
   b. presses on the upper arm, Sketch 88, which presses on the roller of the shift set up lever. This lever is actuated:
      (1) to raise the lip so the shift set up latch will move under the lip, Fig. 1.
      (2) so the trip lever is positioned over the delatching lever by moving the trip lever actuating lever, Fig. 2.
      (3) so the actuating lever latch drops over the stud of the trip lever actuating lever, Fig. 2. This latch was conditioned to drop when the shift set up lever was actuated on the key depression. (Early models of tabulation do not have this actuating lever latch).
      (4) so the upper end pushes the right shift clutch controller to the rear. The controller actuates the walking beam interlock to assist in restoring the left shift clutch controller, Fig. 2.

ENTER DIVIDEND: (cont'd)



SKETCH 89

The continued rotation of the drive shaft:

2. completes the left shift and carriage clear and shifts the carriage to the right. The right shift will continue until the depressed tab stop contacts the stud on the tabulator actuating lever, Sketch 89. This lever will depress the shift actuating lever. This causes (simultaneously);
   a. the delatching of the shift set up latch which restores the shift set up lever to allow the right shift rod to restore.
   b. the trip lever to press on the delatching lever for delatching the setting lever latch from the setting lever. (The trip lever is held in position for an instant by the actuating lever latch). This holds the trip lever over the delatching lever to insure the delatching of the setting lever.
   c. The Setting Lever actuated by a heavy spring drops and:
      (1) actuates the gate actuating lever which is clutched to the gate shaft, Sketch 90, Fig. 1. This action places the add-subtract gate into the add position and the keyboard value is entered into the upper dials.
      (2) causes the upper end of the gate actuating arm to disengage the lock bar for the restoring of the enter dividend key, Fig. 1. The restoring of the key restores the clutch opening shaft: To delatch the oscillating latch; to release the clutch release dog and the switch; to release the keyboard clear link so the link will position to clear the keyboard.
      (3) actuates or holds the counter blocking lever under the locking lip of the #1 counter tooth and lock assembly, Fig. 2. This prevents the entry into the counter dial as the entry is made in the upper dials.
      (4) causes the clutch to remain released and the switch closed for an extra cycle after the restore of the key, Sketch 91. This is necessary to give the entry cycle because the key is released when the drive shaft is near home position and would normally stop. Fig. 2 shows the early style method. Fig. 1 shows the revised style method.

The last part of the last drive shaft cycle will cause the relatch roller to restore the setting lever to the setting lever latch, through the relatching lever link, Sketch 91. The clutch will open and the switch opens to stop the drive shaft rotation.

The delatching of the oscillating latch will release the shift engaging levers shaft. The auto clear lever causes the control lever to hold the shift set up latch away from the lip of the shift set up lever when the shift actuating lever is not being held down by a tab stop.

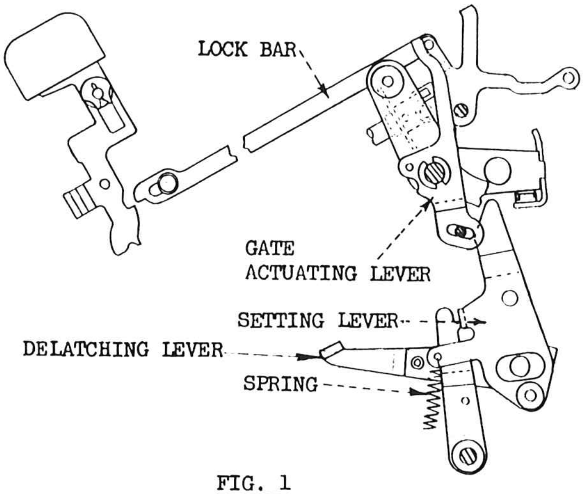


FIG. 1

SKETCH 90

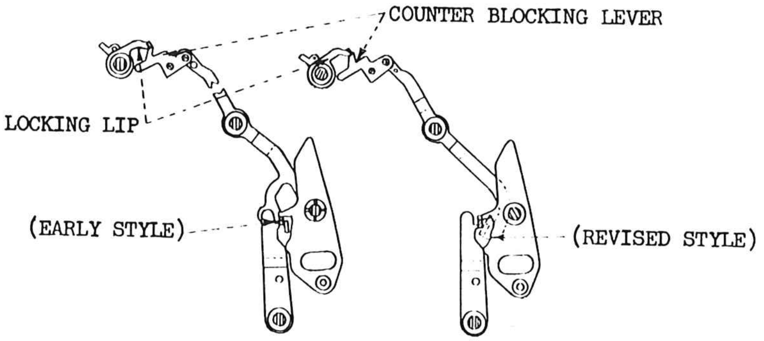


FIG. 2

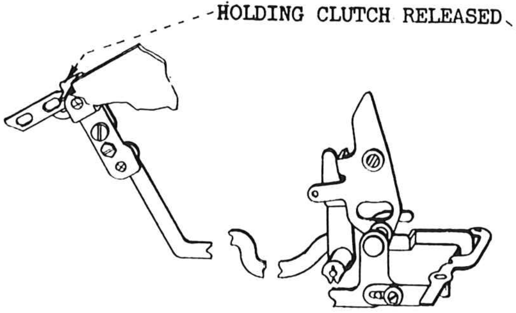


FIG. 1
(Revised Style)

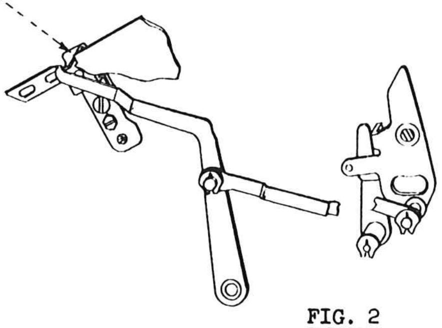


FIG. 2
(Early Style)

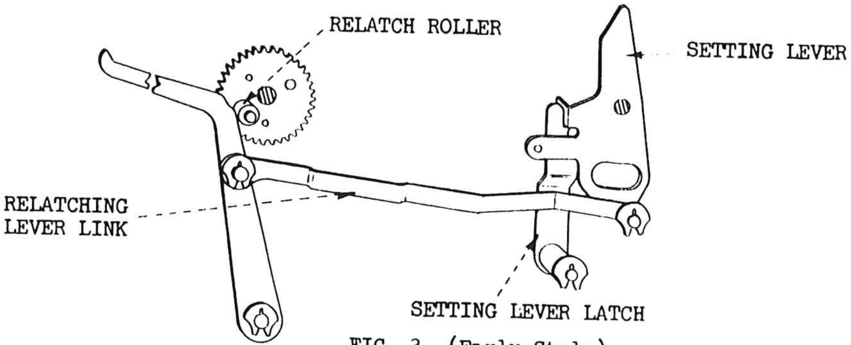


FIG. 3 (Early Style)

SKETCH 91

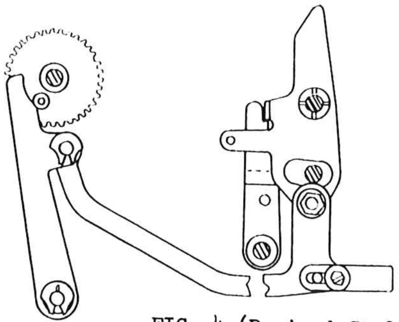


FIG. 4 (Revised Style)

ENTER DIVIDEND: (cont'd)

Additional Operations of Tabulator Parts.

The models having the actuating lever latch have a latch release lever, Sketch 92. This lever is to delatch the latch should the enter dividend key be held down when the carriage reaches the depressed tab stop. This is to prevent the setting lever from tripping more than once.

For several years the #9 tab stop was not permanently set (fixed) for a dividend entry. Machines not having the fixed 9 stop would give no dividend entry when the carriage tabulated to the extreme right. This caused a large number of service calls until the stop was fixed to always cause an entry.

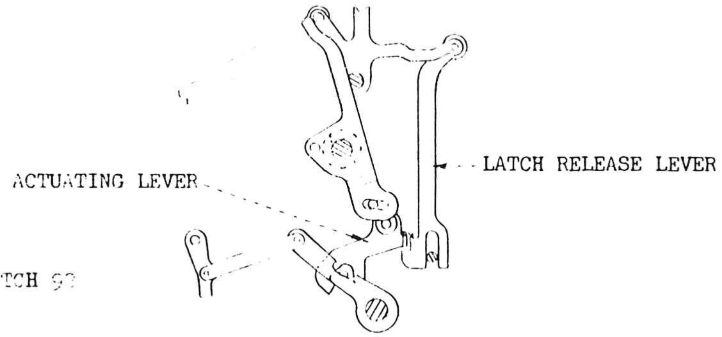
Later models, STW, CW, SRW have the fixed 9 stop. Some model ACG's have it, but, the later ACG's with the auto division stop feature do not have the fixed 9 stop. (The auto division stop is covered later).

Machines not having the fixed 9 stop were restored to home position by the left override pawl action when the carriage tabulated to the extreme right, Sketch 93. The left override pawl depressed the bellcrank, actuating the disabling lever to cause the tabulator key release lever to actuate the release lever, thereby pulling the lock bar from the enter dividend key. The key restored and restored the clutch opening shaft and delatched the oscillating latch. When the oscillating latch releases the roller, Sketch 94 the auto clear lever moves the control lever to delatch the shift set up latch. When this occurs, the right shift disengages and the parts restore to home position.

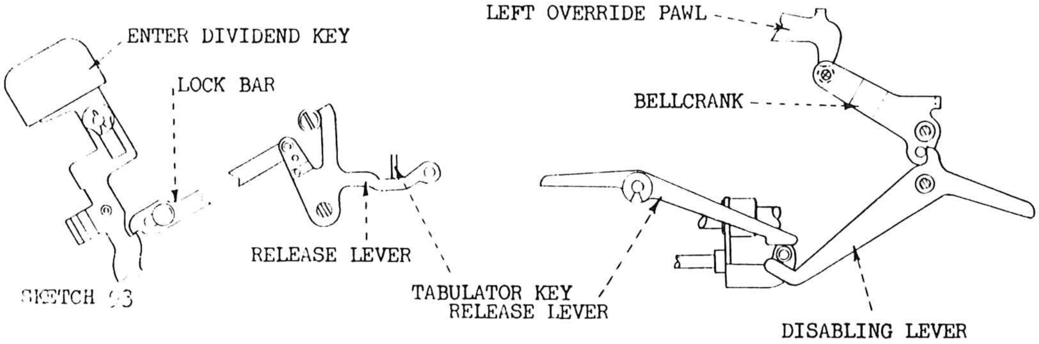
When in home position, the control lever, holds the shift set up latch from the lip of the shift set up lever. The control lever delatches the shift set up latch as mentioned above and also when the tab key is restored by pushing up on the division stop lever.

DISABLING OF GATE SETTING LEVER BY KEYBOARD LOCK KEY:

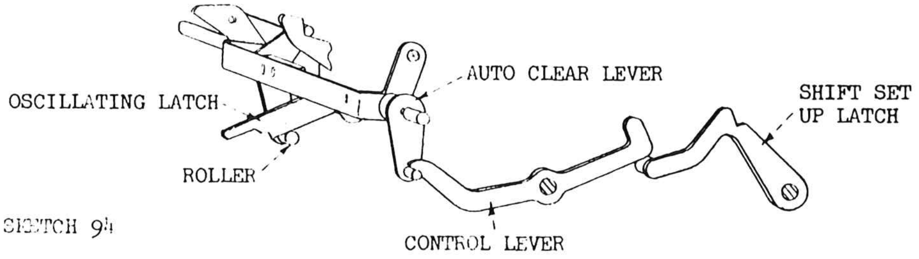
When the keyboard lock key is pulled forward, it causes a link to actuate a bail to disable the gate actuating lever from the collar on the add-subtract gate. This prevents the dividend entry, Sketch 95.



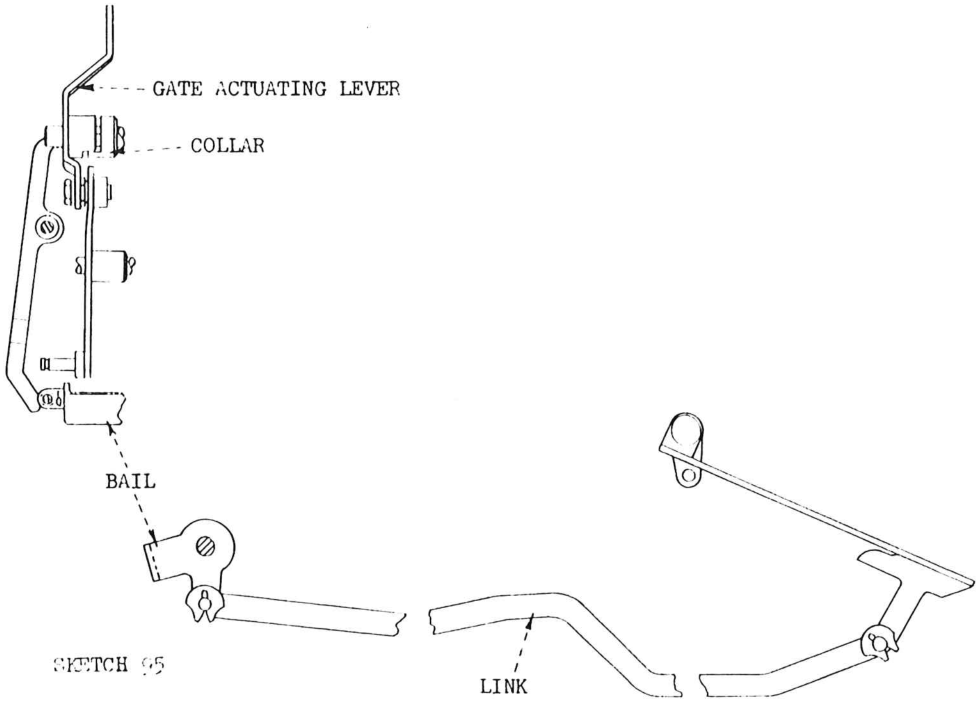
SKETCH 92



SKETCH 93



SKETCH 94

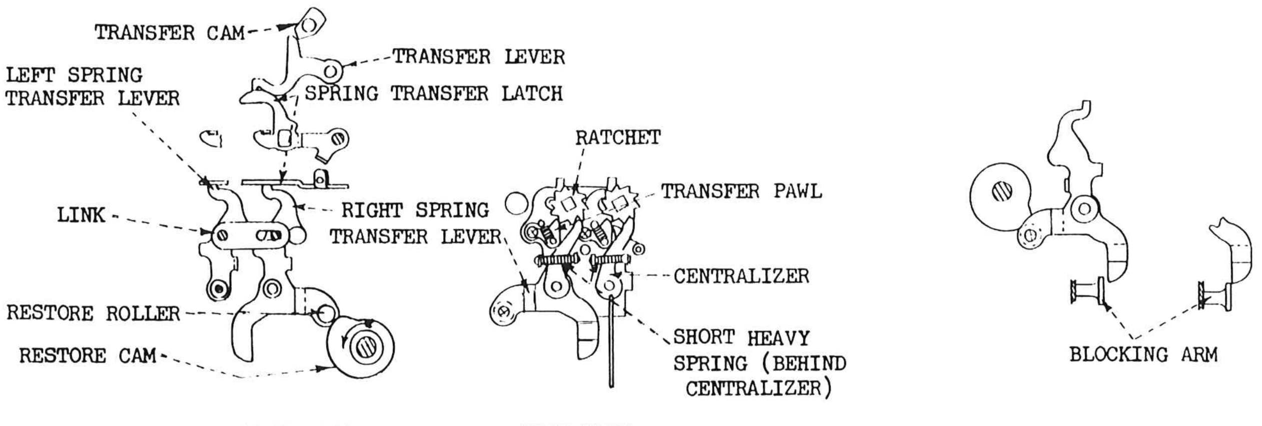


SKETCH 95

SPRING TRANSFER

(13th and 14th position carryover)

This is a feature for adding extra capacity to the accumulator dials. The parts are spring actuated and cam restored. This feature is found on the 10-bank models and on the later complete capacity models. Its purpose on the complete capacity model is to serve as a booster to the complete capacity dials. This is covered in the explanation on that feature.



FRONT VIEW REAR VIEW

SKETCH 96

OPERATION OF SPRING TRANSFER:

Have the upper dials cleared and the carriage in first position. Place a figure in the first keyboard column. Depress the minus key and rotate the hand crank. The dials will start turning from 0 to 9, progressing to the left. When the number 12 dial turns from 0 to 9 the 13th and 14th dials will turn practically instantaneously and simultaneously. Actually the 14th dial turns slightly later because the 13th dial must turn enough to trip the 14th dial.

The transfer cam on the #12 dial actuates its transfer lever which depresses the spring transfer latch and releases the right spring transfer lever. The short heavy spring pulls the lever to the left and the transfer pawl turns the ratchet. Attached to the ratchet shaft is the add-subtract gear and this being in mesh with the 13th accumulator dial causes the dial to turn. The transfer cam of the 13th dial actuates its transfer lever which depresses the spring transfer latch of the 14th order. The latch releases the left transfer lever which is then spring actuated and the transfer pawl turns the ratchet of the 14th order which in turn causes the add-subtract gear to rotate the 14th accumulator dial. The ratchet is kept from rotating after transfer by the stud moving into the ratchet tooth space. The transfer levers are restored by the action of the restore cam on #6 actuator against the restore roller. The right spring transfer lever is restored and it pulls the left one by a link. During restore, the transfer pawls are pulled out of the ratchet to detent into the next tooth space for the next transfer. As the pawls are pulled out, the ratchets are kept from rotating by the centralizers. The spring transfer levers are kept from operating in division by the action of the blocking arm.

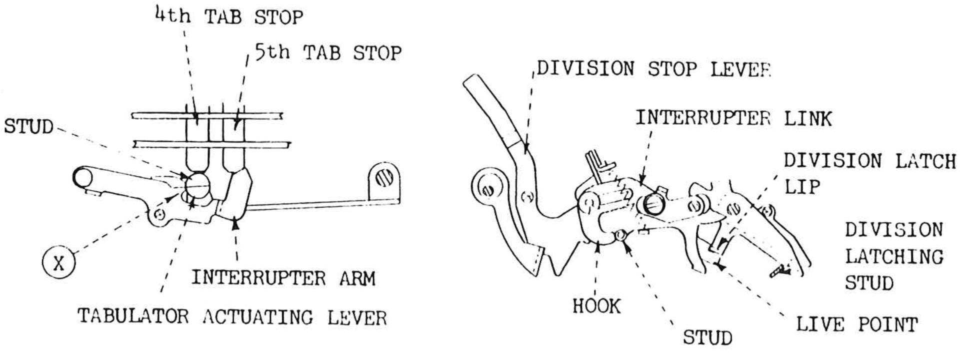
We have used minus to illustrate the transfer action, however, it operates in plus in the same manner. When the accum dial in line with the 12th order add-subtract gear transfers from 9 to 0 the 13th order spring transfer will operate. When the dial in line with the 13th order transfers from 9 to 0, the 14th order spring transfer will operate. The spring transfer action occurs just before the cycle lock pin reaches the notch in the cycle lock disc, Sketch 10.

AUTOMATIC DIVISION STOP:

This is a feature to stop the machine in division when the answer is not desired to be carried beyond the decimal point. The feature uses part of the tab mechanism plus additional parts. The tab stop that determines the decimal point is depressed and at the same time the tab stop to the left is depressed. It is used on the ACG and can be put on the STW and CW.

As an example, set the decimal at the 4th position, depress the 4th tab stop and the 5th tab stop. Place $625.00 in the keyboard add key down, and depress the enter dividend key. Place $25.00 in the keyboard and depress the division keys. The machine will align the carriage then divide and will stop when the carriage shifts past the decimal point.

The feature works in this manner: As the carriage shifts to the left, the 5th tab stop depresses the interrupter arm and raises the hook of the interrupter link into engagement with the stud. Continued left shift causes the 4th tab stop to depress the stud of the tabulator actuating lever. The stud holds the interrupter link in position at Point X. As the add-subtract gate moves to the add position the interrupter link actuates the division stop lever forward. This engages the live point with the lip of the division latch. As the add-subtract gate moves to the central position the division latching stud moves off the division latch and the machine restores to home position.



SKETCH 97

COMPLETE TRANSFER:

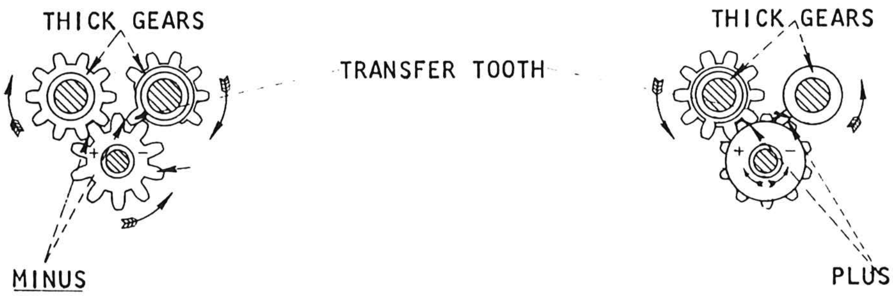
This feature gives the accumulator dials a means of transferring in all 20 dials. To demonstrate, have the carriage clear and in first position. Place a 1 in the first keyboard column, depress the minus key and rotate the hand crank. When the 12th dial turns to 9 the 13th through 20th dials will turn from 0 to 9 simultaneously. The complete capacity parts cause this action in the 13th to 20th dials. Remember on the standard machine that has the spring transfer (13th & 14th position carryover) that the transfer stopped after the 14th dial turned to 9. Depressing the plus key and rotating the hand crank will rotate the dials from 9 to 0.

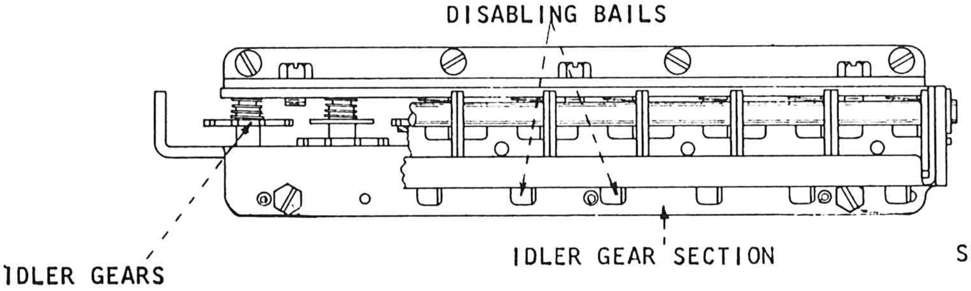
The means for causing this transfer is located in the left end of the carriage. The 12th through 20th dials are special in that each has a thick gear with a transfer tooth and located on the carriage in front of these dials is the idler gear section, Sketch 98. This section consists of 8 idler gears, 8 idler gear disabling bails, and a blockout bail.

The thick dial gears are staggered with one having an extended transfer tooth on the thick gear and one having an individual transfer tooth located below the thick gear. The idler gears mesh with these thick gears to turn the dials and they are out of mesh during carriage clear. The disabling bails cause the disabling of the idler gears.

There are two types of complete transfer mechanisms which are identical with the exception of the time of idler gear engagement and disengagement. Briefly, the early style mechanism engaged the idler gears during the drive shaft cycle for plus and minus and kept them disengaged at all other times. The revised style has the idler gears in mesh at all times except during carriage clearance.

REVISED STYLE:





SKETCH 98

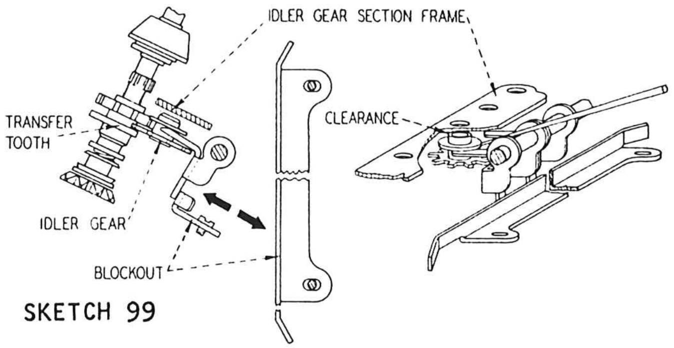
When the carriage is in the first position the idler gears are in mesh with the thick gears and in line with the transfer tooth of each dial. As the 12th dial turns from 0 to 9 in minus, the transfer tooth turns the idler gear and the idler gear turns the 13th dial. The transfer tooth of the 13th dial turns the next idler gear and the transfer wave progresses to the 20th dial. The depression of the plus key will cause the same action to bring the dials to 0.

The later machines have had the spring transfer mechanism added, Sketch 96. This feature gives a boost to the complete transfer wave to insure that the transfer will be completed to the 20th dial should the carriage become loosened during use of the machine.

REVISED STYLE COMPLETE TRANSFER:

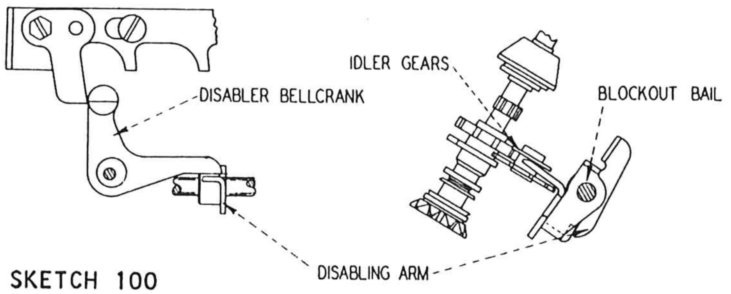
The idler gears are disengaged from contact with the transfer tooth by the idler gear disabling bails in the following manners:

1. When the carriage shifts one position to the right, the blockout actuates the disabling bail for the idler gear between the 12th and 13th dials, Sketch 99. As the carriage continues to shift to the right, the other disabling bails are actuated to raise their idler gears. The raising of the idler gear allows the transfer in these positions to occur in the normal manner.



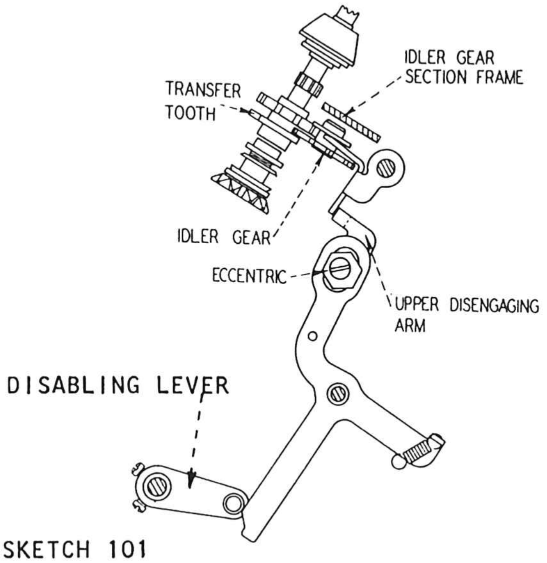
SKETCH 99

2. When the carriage is cleared, the blockout bail is actuated by the disabler bellcrank and disabling arm to raise all disabling bails above the transfer tooth, Sketch 100. This allows the dials to clear.



SKETCH 100

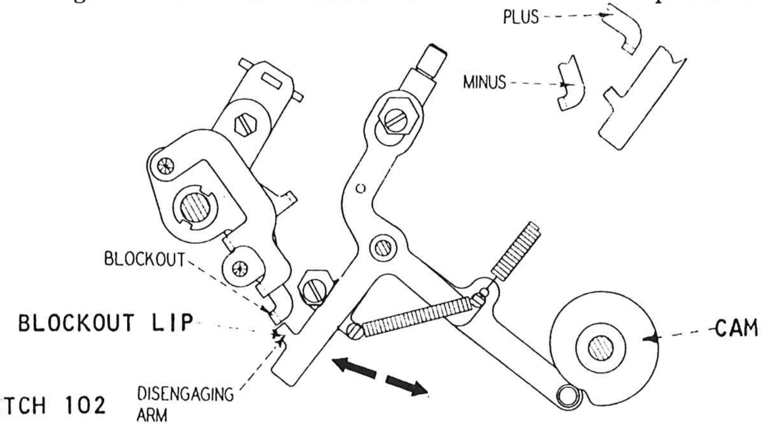
3. When the division keys are depressed, the disabling lever actuates the disengaging arm. The upper end of the disengaging arm actuates the disabling lever in line with it, Sketch 101. This raises the idler gear and stops the overdraft transfer wave past the 12th position accumulator dial.



SKETCH 101

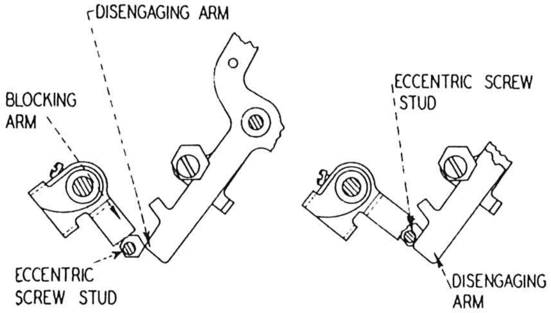
EARLY STYLE COMPLETE TRANSFER:

Since the idler gears on the early style mechanism are normally in a disengaged position, the depression of the plus key and the cycling of the drive shaft cause the add-subtract gate movement to raise the blockout lip from the disengaging arm, Sketch 102. As the drive shaft cycles, the cam causes the upper end of the disengaging arm to move away from the blockout bail. This allows the idler gears to drop by spring action to be in line with the transfer teeth. When the cycle is completed, the cam causes the disengaging arm to raise the idler gears. This same action occurs in minus except that the gate moves to subtract.



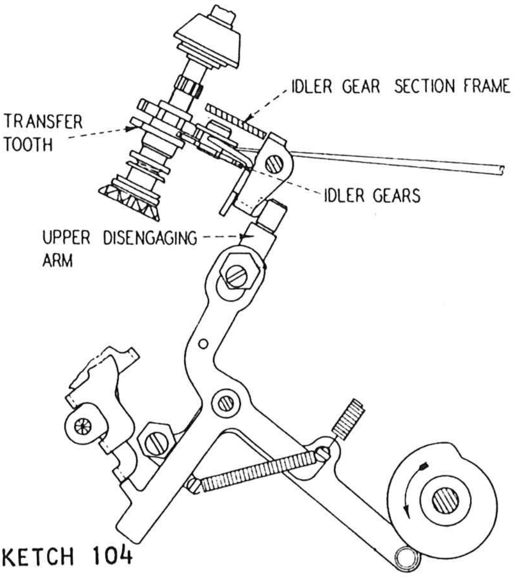
SKETCH 102

The idler gears are kept disabled during division by the eccentric screw stud on the blocking arm raising and stopping the movement of the upper disengaging arm, Sketch 103. The disengaging arm being in two parts, will yield as the cam turns.



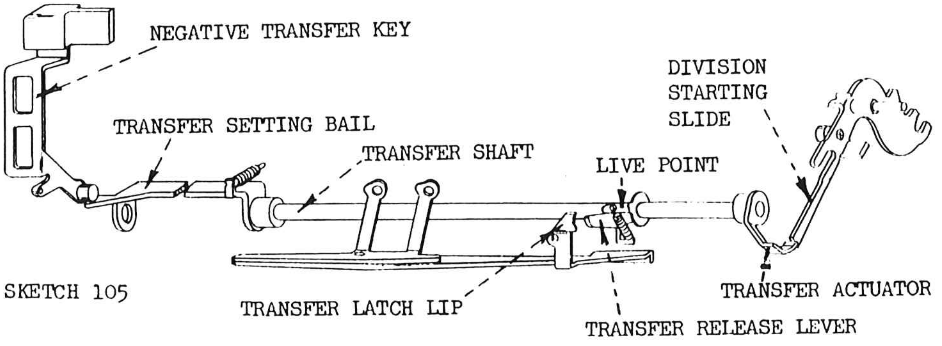
SKETCH 103

The idler gears are kept disabled during shift and carriage clear because the add-subtract gate is not actuated, Sketch 104. Therefore, the blockout lip remains in contact with the disengaging arm and the upper end cannot move away from the blockout bail.

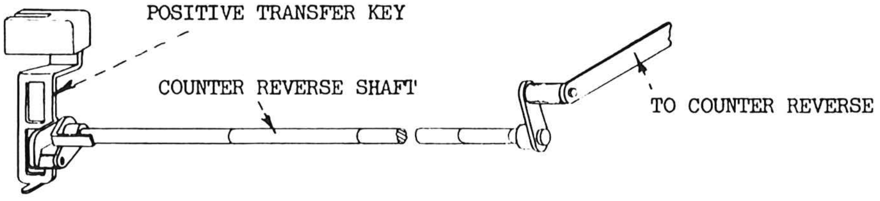


SKETCH 104

ACG TRANSFER:



SKETCH 105



SKETCH 106

This is an automatic means of transferring the figures in the accumulator dials to the counter dials for obtaining a grand total. The feature uses the division mechanism for transferring.

To do a brief simple problem have the Add Key down, the MNE key forward, the counter dials cleared and locked. Cost of 1500 items at $12.50 per thousand. Enter $12.50 in small keyboard and 150000 in the large keyboard. Depress the multiply key. The upper dials read $18.75. Transfer this by depressing both transfer keys. The counter will read $18.75. Next, find the cost of 3500 items at $2.25 per thousand. Enter $2.25 in small keyboard and 350000 in large keyboard. Depress the multiply key. The upper dials read $78.75. Depress both transfer keys. The counter dials read $26.62, the grand total of the two calculations.

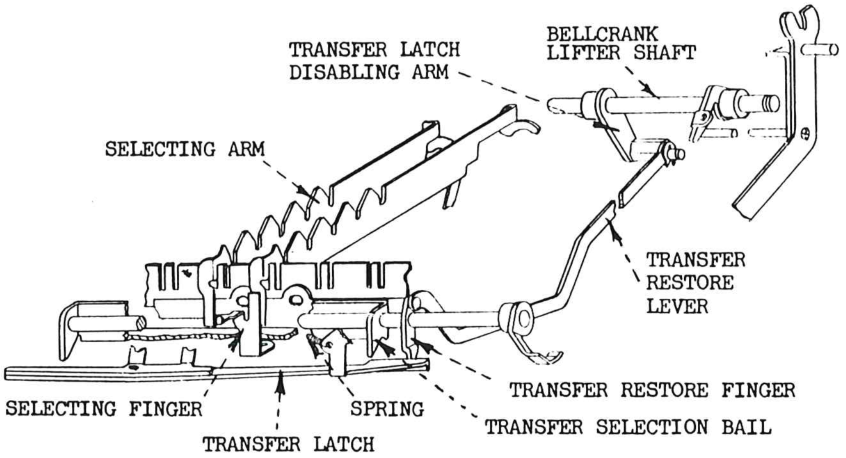
The depression of the Negative and Positive Transfer keys cause the actuation of the division mechanism and the counter reverse mechanism.

The depression of the Negative transfer key, Sketch 105, actuates the transfer setting bail which is pinned to the transfer shaft. At the right end of the shaft is the transfer actuator which moves the division starting slide to the rear and causes the division setting lever to drop and set the machine in divison.

When the Transfer shaft rotates, the live point assembly actuates the transfer release lever below the transfer latch lip.

The Positive transfer key actuates the counter reverse shaft to raise the counter lever for a positive count in the counter, Sketch 106.

ACG TRANSFER: (Cont'd)



SKETCH 107

The tripping of the division mechanism causes the actuation of the bellcrank lifter shaft. This causes the:

1. Transfer latch disabling arm to pull the transfer restore lever to the rear, Sketch 107. This actuates the transfer restore finger to the rear which allows the spring on the Transfer latch to move the latch rearward to actuate the transfer selection bail. The transfer selection bail has a selecting finger which actuates the selecting arm forward enough to bring the selecting gear into alignment with the number one segment of the corresponding actuator.
2. MNE blocking lever, Sketch 85 to be disabled to allow the counter dials to register.

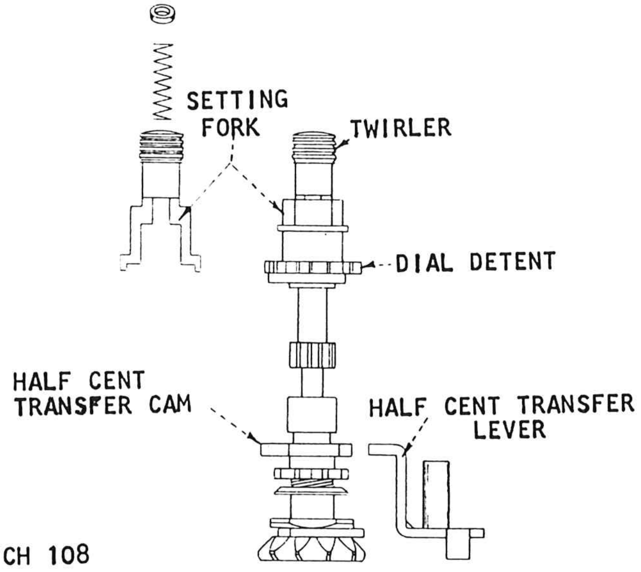
NOTE: The selecting finger can be moved to other positions except the extreme right or for the first column.

HALF CENT/FRACTIONAL DIAL:

This is a feature built into the carriage and using a special accumulator dial that can be set to automatically raise the cents figure one cent. If the mills are 5 or more, the cents figure is raised one cent. The dials show 25.42835. The mills figure is 8, therefore, the figure is copied 25.43.

The first half cent dials could be set at 0 or 5 but the fractional dials can be set from 0 to 9.

The dial has a transfer cam which can be raised or lowered. This is located on the inside of the carriage frame. The cam is in line for contact with a special transfer lever that extends into the carriage frame. The transfer cam is raised by the clearing action of the clear racks.



SKETCH 108

To place a number in the Half Cent or Fractional Dial, hold the Accumulator Rack Clear knob to the right with the right hand. With the left hand raise the twirler, twirl in the number desired, be sure the twirler is seated, then release the accumulator Rack Clear knob.

The right movement of the Accumulator Clear Rack causes the drive bracket to actuate the cam slide, Sketch 109, Fig. 1 below. The slide raises the transfer cam above the transfer lever at same time the zero stop slide pulls the detent spring into the dial detent, Fig. 2. Pulling up on the twirler disengages the setting fork from the dial detent. Turning the dial, rotates the shaft and positions the transfer cam and numeral to a different position than that of the home position of the standard dials.

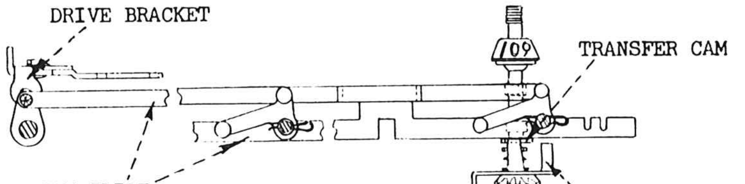


FIG. 1

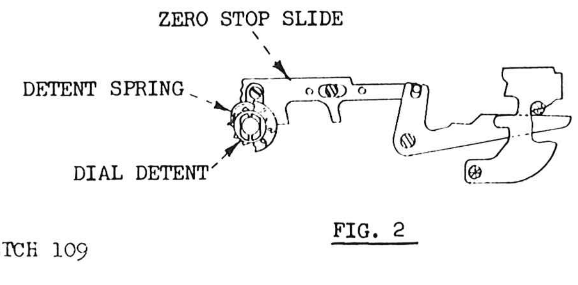
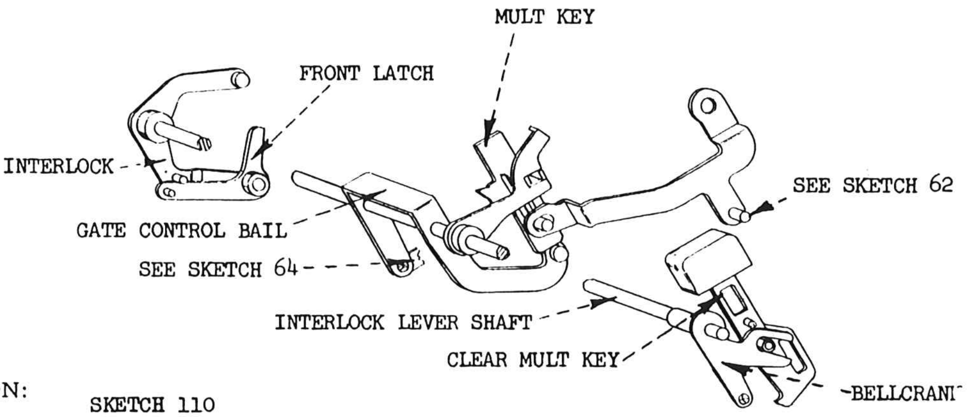


FIG. 2

SKETCH 109

MULTIPLICATION: MODEL SW

This is a multiplier model that does not have the full automatic operational features of the Model STW. The multiplier keyboard has no visible operating keys but has a setting lever which is pre-set to determine the particular multiplication operation: multiplication, negative multiplication, and multiply correction. The clear mult key (carriage clear key) is used for setting the machine into multiplication.



SKETCH 110

MULTIPLICATION:

A selection is entered in the same manner as on the STW. Use the set up that you used before for multiplication. The depression of the clear mult key actuates the bellcrank which rotates the interlock lever shaft.

1. This causes the mult key actuating lever to depress the mult key. The mult key causes the switch opening and clutch releasing and the positioning of the oscillating lever the same as in Sketch 63.
   (a) the mult key actuates the gate control bail to condition the gate actuating lever per Sketch 67.

2. The interlock lever shaft actuates the interlock to delatch the front latch from the power set shift lever, Sketch 110.

Rotation of the drive shaft will cause:

1. the actuating lever to pick up the stud on the shift shaft oscillating lever and the left shift is set up, Sketch 22.

2. the carriage to shift to first position.
   (a) the override action will occur to disable the rear latch, Sketch 69 and to delatch the left shift and carriage clear. The rear latch is delatched and the power set shift lever drops, Sketch 70. The feed pawl and holding pawl are engaged with the segments. The plus gate engaging lever is engaged with the upper stud of the gate power set arm. The power set cam is positioned over the relatch and delatch levers.

3. the power set cam to operate the pow er set levers, Sketch 71.

4. the feed pawl to feed out the segment, Sketch 72 and the disabling lever will be operated to place the hook over the stud or lip of the shift shaft latch and to disengage the plus gate engaging lever.

5. the roller on the power set cam to actuate the delatching lever, Sketch 73.
   (a) the shift shaft latch will be delatched.
   (b) the adjustment arm will drop. The power set latch is delatched.
   (c) the feed pawl and holding pawl will be disengaged from the segment.
   (d) the carriage shift shaft is operated to position the right shift rod and the unit shift tooth.

6. the right carriage shift and the unit shift. Sketch 73, 74.

7. the adjustment arm to latch up; the carriage shift shaft to restore, Sketch 74.

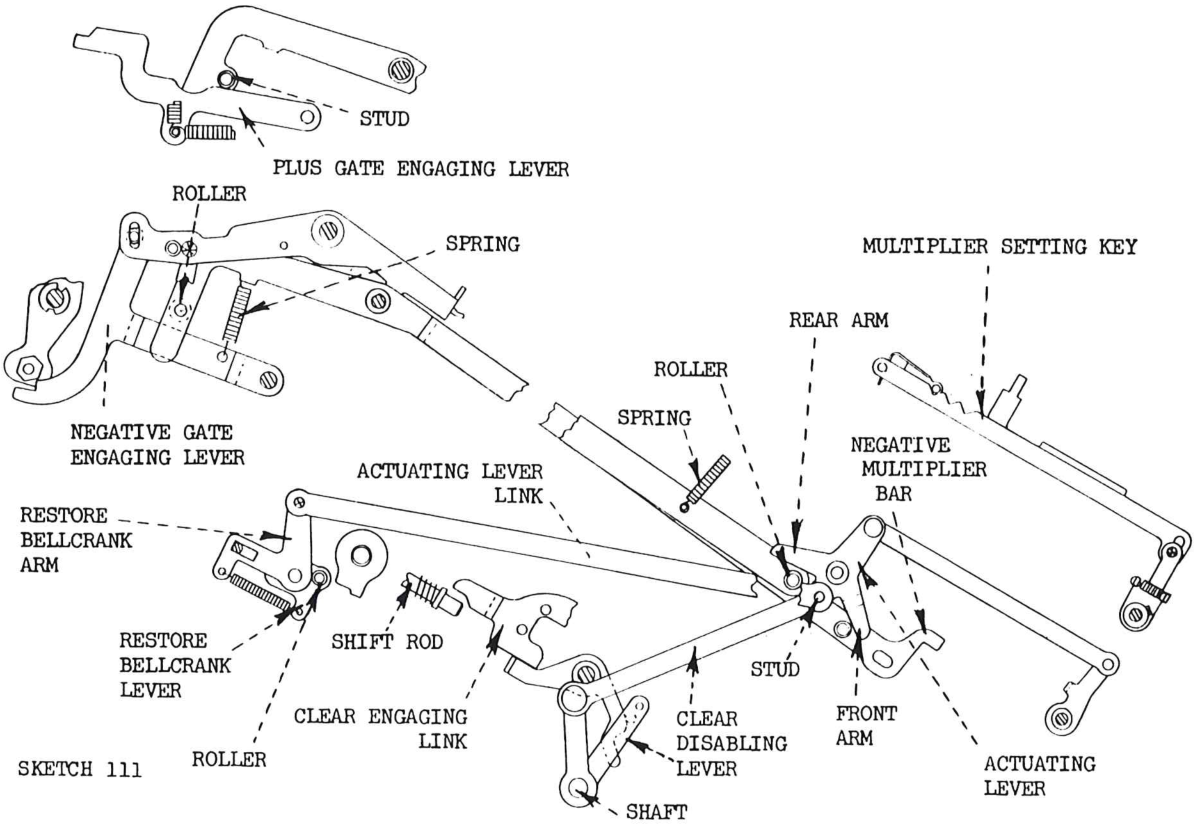
8. the power set cam to operate the power set levers again and the gate is positioned.

9. the segment is fed out again and the action is the same as before.

10. the feeding out of the last segment and the last unit shift is the same as in Sketch 75. When the mult key is restored, the clear mult key restores. This allows the front latch to move under the power set shift lever. The restoring of the mult key releases the clutch opening shaft which restores the oscillating latch and the shift levers. The drive shaft will stop when reaching home position.

NEGATIVE MULTIPLICATION: MODEL SW

Since the Model SW does not have a negative multiply key, it is necessary to pull the setting lever forward to the negative position so the minus sign on the multiplier setting key shows in the top cover hole. Use the same set up as used for multiplication.



SKETCH 111

The forward movement of the multiplier setting key pivots the actuating lever which causes:

1. The front arm to depress the front of the Negative Multiplier bar. This causes the rear to rise and moves the roller from the negative gate engaging lever. This action adds tension to the spring between the two parts.

2. The stud, located in the lower center of the actuating lever to actuate the clear disabling lever. This action rotates the shaft which results in the carriage clear disabling lever raising the clear engaging link above the clear shift rod.

3. The stud, located in the lower center of the actuating lever to move the actuating lever link rearward. This pivots the restore bellcrank arm to raise the roller of the restore bellcrank lever.

4. The rear arm to move away from the roller on the multiplier bar lever. This allows the spring to actuate the bar to lower the rear end so the stud holds down the plus gate engaging lever.

The depression of the clear mult key causes the switch opening and clutch closing and the positioning of the oscillating lever, Sketch 110, 63. Also the raising of the gate actuating lever, Sketch 67, and the delatching of the front latch, Sketch 110.

Rotation of the drive shaft will cause:

1. the actuating lever to pick up the stud on the shift shaft oscillating lever and the left shift is set up, Sketch 22.

2. the carriage to shift to first position.
   (a) the override action will occur to disable the rear latch, Sketch 69 and to delatch the left shift. The rear latch is delatched and the power set lever drops, Sketch 70. The feed pawl and holding pawl are engaged with the segments. The negative gate engaging lever is engaged with the lower

NEGATIVE MULTIPLICATION: (Cont'd)

stud of the gate power set arm, Sketch 78. The power set cam is positioned over the relatch and delatch levers, Sketch 70, Fig. 2.

3. the power set cam to operate the power set levers, Sketch 78.

4. the feed pawl to feed out the segment, Sketch 72 and the disabling lever will be operated to place the hook over the stud or lip of the shift shaft latch and to disengage the negative gate engaging lever.

5. the roller on the power set cam to actuate the delatching lever, Sketch 73.
   (a) the shift shaft latch will be delatched.
   (b) the adjustment arm will drop. The power set latch is delatched.
   (c) the feed pawl and holding pawl will be disengaged from the segment.
   (d) the carriage shift shaft is operated to position the right shift rod and the unit shift tooth.

6. the right carriage shift and the unit shift, Sketch 73, 74.

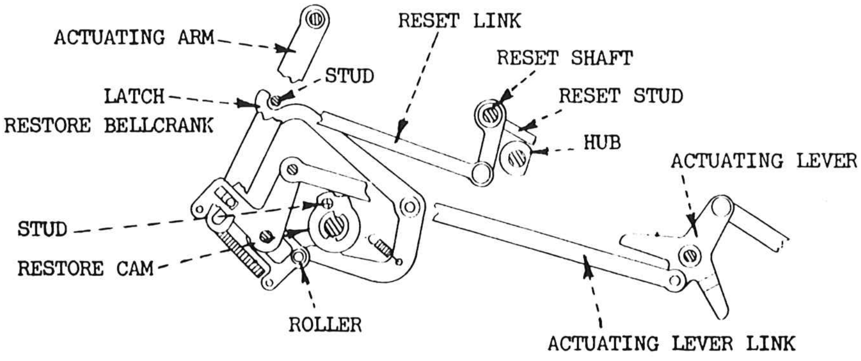
7. the adjustment arm to latch up; the carriage shift shaft to restore, Sketch 74, Fig. 2.

8. the power set cam to operate the power set levers again and the gate is positioned.

9. the segment is fed out again and the action is the same as before.

10. the feeding out of the last segment and the last unit shift is the same as in Sketch 75 with an additional operation, Sketch 112 below.
    (a) as the unit makes the last right shift, the hub on the unit left frame actuates the reset stud. The stud movement rotates the reset shaft thus pulling the reset link forward. The link moves the actuating arm so the restore bellcrank is moved forward to position the roller close to the restore cam. The movement of the actuating arm allows the latch to engage the stud. This holds the roller in position when the unit shift tooth disengages from the shift rack.
    (b) The lobe of the restore cam contacts the roller, thus pivoting the restore bellcrank arm and lever. This action through the actuating lever link pivots the actuating lever which causes:
        (1) the setting key to restore to the multiply (rearward) position.
        (2) rear arm of the actuating lever to depress the roller on the multiplier bar lever thus raising the rear end.
        (3) the front arm to move from contact with the roller on the negative multiplier bar, thus allowing the rear end to lower by spring tension.
        (4) the stud, to allow the clear disabling lever to move forward by spring tension to engage the clear engaging link with the shift rod.
    (c) The stud on the restore cam actuates the latch and releases the actuating arm and the restore bellcrank arm and lever to home position.

When the mult key was released, the oscillating latch was released and the clutch opening shaft restored to allow the clutch to close as the drive shaft reached home position.



SKETCH 112

MULTIPLY CORRECTION: MODEL SW

The multiply correction action clears the unit by feeding out the segments one at a time and shifting the unit to the right. To operate the machine in multiply correction, pull the multiply setting key to the central position or so the C sign is showing in the top cover hole.

Select 22 in the multiplier unit.

The positioning of the multiplier setting key pivots the actuating lever which causes:

1. the front and the rear arms to hold the rollers of the negative multiplier bar lever and the multiplier bar lever, Sketch 113. This allows the rollers at the rear of the bar levers to hold the plus gate engaging lever and the negative gate engaging lever.

2. the stud, located in the lower center of the actuating lever to actuate the clear disabling lever. This action rotates the shaft which results in the carriage clear disabling lever raising the clear engaging link above the clear shift rod.

3. the stud, located in the lower center of the actuating lever to move the actuating lever link rearward. This pivots the restore bellcrank arm to raise the roller of the restore bellcrank lever.

The positioning of the multiplier setting key actuates the clear disabling actuating arm, Sketch 114. The roller on this arm positions on the approximate point of the clear disabling lever. This causes the disabling shaft to actuate the clear disabling bellcrank which moves the keyboard block lever so the lip depresses the keyboard clear link below the keyboard clear gate. This action is to pre-set the parts to prevent a keyboard clear at the end of multiply correction when the key restores.

The rotation of the drive shaft will cause:

1. the actuating lever to pick up the stud on the shift shaft oscillating lever and the left shift is set up, Sketch 22.

2. the carriage shift to first position.
   (a) the override action will occur to disable the rear latch, Sketch 69 and to delatch the left shift. The rear latch is delatched and the power set lever drops, Sketch 70. The feed pawl and the holding pawl are engaged with the segments, but the plus and the negative gate engaging levers are not engaged with the studs of the gate power set arm. The power set cam is positioned over the relatch and delatch levers, Sketch 70, Fig.2.

3. the power set cam to operate the power set levers and the power set latch latches up, Sketch 71.

4. the feed pawl to feed out the segment, Sketch 72 and the disabling lever will be operated to place the hook over the stud or lip of the shift shaft latch.

5. the roller on the power set cam to actuate the delatching lever, Sketch 73.
   (a) the shift shaft latch will be delatched.
   (b) the adjustment arm will drop. The power set latch is delatched.
   (c) the feed pawl and the holding pawl will be disengaged from the segment.
   (d) the carriage shift shaft is operated to position the right shift and the unit shift tooth.

6. the right carriage shift and the unit shift, Sketches 73, 74.

7. the adjustment arm to latch up; the carriage shift shaft to restore, Sketch 74.

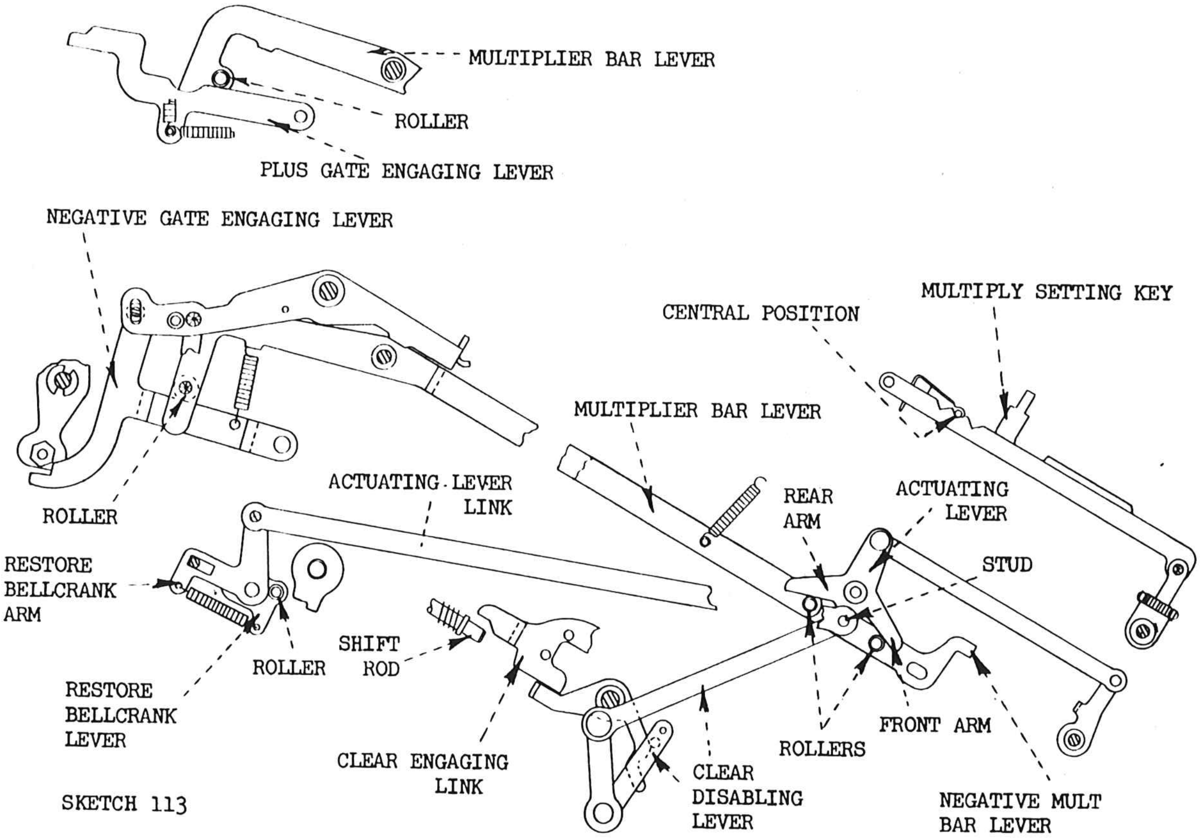
8. the power set cam will operate the power set levers again.

9. the segment is fed out again and the action is the same as before.

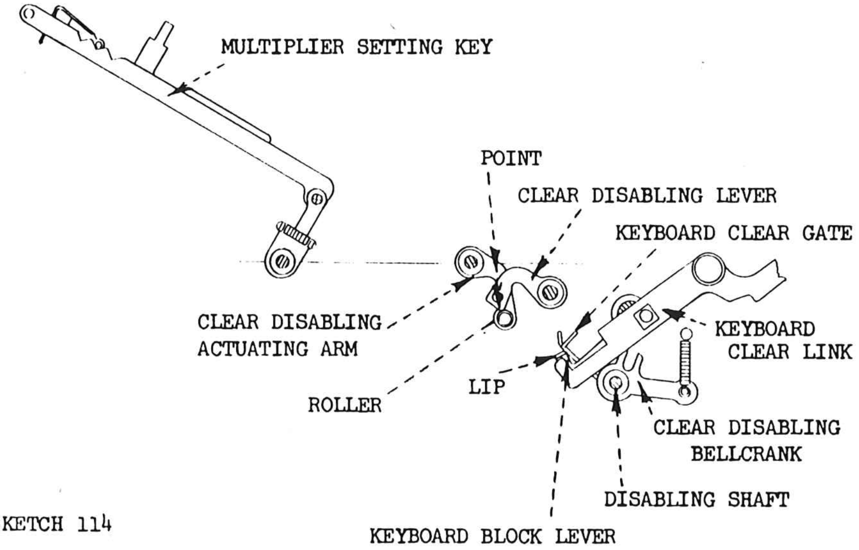
10. the feeding out of the last segment and the last unit shift is the same as in Sketch 75 with the additional operations in Sketch 112.

When the multiply setting key restores, the roller on the clear disabling arm moves off the point of the clear disabling lever. This restores the keyboard block lever and allows the keyboard clear link to restore to home position. Observe that before the above action takes place, the keyboard clear link has moved rearward under the keyboard clear gate.

When the multiplier key was released, the oscillating latch was released and the clutch opening shaft restored to allow the clutch to close as the drive shaft reached home position.



SKETCH 113



SKETCH 114